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DRAFT FINAL FEASIBILITY STUDY

**IRON HORSE PARK SUPERFUND SITE
OPERABLE UNIT 4
North Billerica, Massachusetts**

October 2010

Prepared By:

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EXECUTIVE SUMMARY

A feasibility study (FS) was prepared by Metcalf & Eddy | AECOM (M&E) for the 4th Operable Unit (OU) at the Iron Horse Park Superfund Site (the site) in North Billerica, Massachusetts. The FS was undertaken utilizing the remedy selection process with the goal of selecting remedies that are protective of human health and the environment, that maintain protection over time, and that minimize untreated waste. This report describes the process used to develop preliminary alternatives and includes a detailed evaluation and comparative analysis of these alternatives for groundwater and sediment. Surface water is also discussed due to its relationship to both groundwater and sediment; however, evaluation of surface water did not result in a determination of unacceptable risk at the site and does not require remedial action.

The Iron Horse Park Superfund Site occupies approximately 553 acres in North Billerica, Massachusetts, near the Tewksbury town line, approximately 20 miles northwest of Boston. The site is bounded on the north by the B&M railroad tracks, on the west by High Street and an auto auction facility, on the east by Gray Street, and on the south by a wetland, Pond Street, and the Middlesex Canal. The Middlesex Canal flows through the site to the east, where it joins Content Brook at the southeastern edge of the Shaffer Landfill. It then flows to the Shawsheen River and ultimately to the Merrimack River to the north. There are abundant wetlands and forested areas at the site. In addition, several large wetland complexes border the site, which increase the total acreage of the wetlands at the site to 266 acres. Groundwater in both the overburden and bedrock aquifers generally enters the site from the southwest and flows to the northeast. Similarly, surface water flows onto the site from the south and flows to the northeast, where it converges with B&M Pond and associated wetlands. The potential for groundwater to discharge to surface water is evident throughout most of the site.

The site is divided into four operable units (OUs). OU-1 is the Boston & Maine (B&M) Wastewater Lagoons, OU-2 is the Shaffer Landfill, and OU-3 was originally the remainder of the site, including an active industrial complex (the Iron Horse Industrial Park), a railyard, numerous

manufacturing operations, open storage facilities, landfills, and lagoons. Investigational activities, including a baseline ecological risk assessment (BERA) and baseline human health risk assessment (HHRA), were completed for OU-3 in 1997. At the time of the FS for OU-3, completed in 2004, it was decided that site-wide surface water, sediment, and groundwater required additional investigation and the OU-3 FS was then limited to site source areas. Therefore, OU-4 includes residual groundwater, surface water, and sediment contamination following the source control measures that will be implemented for OU-3. It should be noted that groundwater associated with Shaffer Landfill (OU-2) is not included as part of the OU-4 evaluation.

The previous investigations described in the OU-3 remedial investigation/feasibility study (RI/FS) established that the concentrations of some groundwater contaminants exceed applicable or relevant and appropriate requirements (ARARs) or contribute to risk in excess of regulatory guidelines. Additional groundwater studies conducted as part of the OU-3 RI/FS included groundwater modeling, which utilized site-specific information such as boring logs, slug tests, water levels from monitoring wells and staff gauges, and stream seepage tests to simulate groundwater migration and estimate relative times to achieve remedial action objectives (RAOs) for groundwater cleanup. The modeling indicated that, in most cases, the time to reach RAOs was far greater than 30 years. As a result, EPA decided to address potential groundwater cleanup by initially performing source control measures, then monitoring groundwater and evaluating trends in contaminant concentrations that result from those actions.

Based on the results of the OU-3 HHRA and BERA, M&E was charged with conducting additional investigative activities in site wetlands and ponds, preparing a focused ecological risk assessment/wetland remedial investigation addendum (ERA/WRIA), performing additional monitoring well installation and groundwater sampling activities, and preparing a focused FS for the site (OU-4) in order to support selection of a remedy to control ecological risks to the environment and to supplement the RI (M&E, 1997) and FS (M&E, 2004) for OU-3.

Surface water and sediment supplemental characterization was initiated in 2004, with a data

evaluation report (M&E, 2005) and an ERA/WRIA (M&E, 2006a) generated. Supplemental groundwater characterization was performed in 2005 and 2006, with a data evaluation report generated (M&E, 2006b). An additional supplement to the groundwater data evaluation report was also generated in 2008 (M&E, 2008).

Based on the results of the RI, supplemental investigations, and risk assessments conducted for the site, contaminants identified at the site pose risk to ecological (sediment) and human (groundwater) receptors and require remediation.

Groundwater. The human health Remedial Action Objectives (RAOs) for site-wide groundwater include specific objectives to reduce risks and hazards identified in the supplemental HHRA as above EPA's risk management criteria. With most of the groundwater under the site designated as a non-potential drinking water source area, as well as lack of a well-defined contaminant plume, a compliance zone boundary has been designated for the site. While one groundwater RAO has been developed to prevent exposures to contaminated groundwater by future residential users, another RAO has been developed to prevent migration of contaminated groundwater beyond the compliance boundary to limit potential off-site exposures to residences with private wells.

RAOs were developed under the assumption that scheduling of remedial actions (source control) associated with OU-3 will be performed in such a manner that recontamination of groundwater resulting from future contaminant migration to groundwater will be limited.

Sediment. RAOs for sediment were developed based on the results of the ERA/WRIA conducted for contaminated media specific to each area of concern (M&E, 2006a). The media/areas of concern requiring RAOs include: (1) sediment in Unnamed Brook; and (2) sediment in B&M Pond.

The Unnamed Brook and associated wetlands are adjacent to an operating railyard and other commercial/industrial facilities. Results presented in the ERA/WRIA and summarized in Section

1.4.1 have determined that the system is performing as wetlands typically do. According to the data, the wetland complex appears to be acting as a sink for stabilizing and burying contaminants associated with sediments that may be transported to the wetland via resuspension and run-off within the Unnamed Brook. This process appears to have limited off-site migration of those contaminants that have become stable within the wetland of the Unnamed Brook and have not migrated further downstream. Therefore, while it appears that existing natural mechanisms will continue to reduce ecological exposures to sediment contaminants in Unnamed Brook, limiting site storm water runoff will be necessary to limit further recontamination of sediment and reduce the timeframe of recovery.

The ecological RAOs for the site include specific objectives to reduce risks identified in the ERA/WRIA as unacceptable. RAOs were developed under the assumption that scheduling of remedial actions (source control) associated with OU-3 and remedial actions associated with OU-4 groundwater will be performed in such a manner that recontamination of sediment resulting from future contaminant migration will be limited.

General response actions (GRAs) are developed to satisfy the RAOs for the site. The range of applicable general response actions determined to be potentially applicable for each medium/area of concern's RAOs is as follows:

Groundwater:

- No Action
- Institutional Actions

Sediment:

- No Action
- Institutional Actions
- Source Control (capping/containment)
- Source Control (excavation/dredging)
- Source Control (on-site disposal)
- Treatment: Off-Site
- Treatment: In-Situ
- Treatment: On-Site

No remedial activities would be implemented under the No Action response action. However, per the NCP and RI/FS guidance, it is considered throughout the FS process as a baseline against which other alternatives can be compared.

Following screening of potential remedial technologies associated with each of the general response actions, feasible technologies and process options were combined into comprehensive site remedial alternatives that address the RAOs.

The remedial alternatives for groundwater are discussed below:

Alternative GW-1: No Action

This alternative is developed as a baseline for comparison to other alternatives in accordance with the NCP (U.S. EPA, 1990) and RI/FS guidance (U.S. EPA, 1988). No remedial action occurs in this alternative, except for statutorily required five-year reviews.

Alternative GW-2: Limited Action

Under this alternative, groundwater monitoring would be utilized to confirm that contaminants do not migrate beyond the compliance boundary for any waste management area or into any area of potable groundwater. While Monitored Natural Attenuation (MNA) is not specified as a remedy for the site, there is some evidence that natural attenuation of certain contaminants has been occurring at the site (M&E, 2006b; M&E, 2008b). Groundwater sampling would include MNA parameters in an attempt to develop stronger evidence showing that some contaminants/areas of the site may be attenuating naturally. Institutional Controls (ICs) would be implemented to restrict groundwater use as a potable water supply within the compliance boundary. As contaminants remain on site, five-year site reviews would be conducted to evaluate the remedy per EPA guidance.

The remedial alternatives for sediment are discussed below:

Alternative SD-1: No Action

This alternative is developed as a baseline for comparison to other alternatives in accordance with the NCP (U.S. EPA, 1990) and RI/FS guidance (U.S. EPA, 1988). No remedial action occurs in this alternative, except for statutorily required five-year reviews.

Alternative SD-2: Monitored Natural Recovery (MNR)

Under this alternative, MNR would be established as the primary remedy component. Pre-design evaluation would be necessary to determine if MNR alone will achieve PRGs within a reasonable amount of time. This alternative involves evaluation and monitoring of additional parameters (*e.g.*, sediment types, erosion, and deposition) than those associated with chemistry monitoring. Storm water runoff controls would also be implemented to prevent sediment recontamination. As contaminants remain on site, five-year site reviews would be conducted to evaluate the remedy per EPA guidance. For this alternative, the five-year reviews are critical to determine if contaminant concentrations are being reduced effectively.

Alternative SD-3: Source Control - In-situ Capping

This alternative would cover contaminated sediments in B&M Pond with either natural sediments or an engineered cap. This alternative would prevent direct exposure of ecological receptors to the contaminants. Wetland mitigation due to disturbance during cap construction would be performed, as well as wetland/flood storage capacity replacement via excavation of nearby/surrounding sediments. Periodic monitoring, including MNR parameters, of areas/residuals outside of the cap, including Unnamed Brook, would be performed. Maintenance of the cap would be required over time. Storm water runoff controls would also be implemented to prevent sediment recontamination. As contaminants will remain in place, five-year site reviews would be conducted to evaluate the remedy per EPA guidance.

Alternative SD-4: Source Control – Excavation (B&M Pond) with Disposal

This alternative would involve excavating contaminated sediments in B&M Pond through either

dredging or dry excavation techniques. Wetland mitigation due to disturbance during excavation would be performed, including replacement of excavated sediments with appropriate clean fill. Following dewatering, sediments would be transported to a disposal location; either an off-site facility or an on-site area (*e.g.*, one of the OU-3 AOCs) and placed under a cap. Depending on timing of cap design/placement for those on-site areas, use of this option may be limited. An MNR monitoring program for areas/residuals outside of the excavation, including Unnamed Brook, would also be established. Storm water runoff controls would also be implemented to prevent sediment recontamination. Five-year site reviews would be conducted to evaluate the remedy per EPA guidance.

Alternative SD-5: Source Control - Excavation with On-site Treatment - Chemical Extraction/Soil Washing

This alternative is similar to Alternative SD-4, except that excavated sediments would be treated on-site via chemical extraction/soil washing methods. Pre-design testing would be necessary to determine the appropriate contaminant removal techniques. Following treatment, the sediments would be utilized as fill in the excavated areas. Disposal of wash water, which would require further treatment, is assumed to be performed via groundwater injection.

Alternative SD-6: Source Control – Excavation (B&M Pond and Unnamed Brook) with Disposal

This alternative is similar to Alternative SD-4, except that excavation would also include Unnamed Brook and is assumed to remove contaminants such that an MNR monitoring program would not be necessary.

Initial screening of remedial alternatives was performed to initiate the evaluation of each alternative, specific to each medium and area of concern. In addition, the screening process is used to potentially eliminate one or more alternatives that do not appear advantageous to carry through to detailed evaluation. This initial screening process includes an assessment of the advantages and disadvantages of each alternative on the basis of their effectiveness, implementability, and cost, in accordance with the RI/FS guidance (U.S. EPA, 1988).

Groundwater. As there are only two remedial alternatives related to groundwater (GW-1: No Action and GW-2: Limited Action), screening was not performed and both alternatives have been retained for detailed evaluation.

Sediment. Alternatives SD-1, SD-4, and SD-6 were retained for detailed evaluation. SD-2 was removed from further evaluation due to the lack of lines of evidence of MNR occurring in the areas of highest contamination in B&M Pond. SD-3 was removed from further evaluation due to the anticipated significant wetland alterations which would be expected due to the loss of flood storage capacity resulting from cap construction. SD-5 was removed from further evaluation due to the anticipated high capital cost related to wash water treatment.

Detailed evaluation of the alternatives remaining after screening is needed to provide decision-makers with the necessary information to compare remedial alternatives and select an appropriate remedy for the site that demonstrates satisfaction of the CERCLA requirements. Nine evaluation criteria have been developed to address the CERCLA requirements and to address the additional technical and policy considerations that have proven to be important for selecting amongst remedial alternatives. These evaluation criteria serve as the basis for conducting the detailed analyses during the FS and for subsequently selecting an appropriate remedial action as part of the Record of Decision. These nine feasibility study criteria are as follows:

- overall protection of human health and the environment
- compliance with Applicable, or Relevant and Appropriate Requirements (ARARs)
- long-term effectiveness and permanence
- reduction of toxicity, mobility or volume
- short-term effectiveness
- implementability
- cost
- state acceptance
- community acceptance

Following the detailed evaluation of each of the remaining remedial alternatives, a comparative analysis of the alternatives proposed for each medium/area of concern is presented. The comparative analysis evaluates the relative performance of each of the alternatives versus nine feasibility study criteria. Advantages and disadvantages of each alternative are described in detail.

Overall protection of human health and the environment and compliance with ARARs are the two threshold criteria that must be met by any alternative in order for it to be selected as a proposed remedy. The next five FS criteria (i.e., long-term effectiveness and permanence, reduction of toxicity, mobility and volume through treatment, short-term effectiveness, implementability, and cost) are used to differentiate among the remaining alternatives that meet the threshold criteria. The final two criteria, State and community acceptance, are addressed in the ROD once formal comments on the proposed plan have been received.

Table ES-1 presents an abbreviated comparative analysis of remedial alternatives by media for the threshold criteria and costs.

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SECTION 1.0

INTRODUCTION

The Iron Horse Park Superfund Site (the site) in North Billerica, Massachusetts was placed on the National Priorities List (NPL) in September 1984. This document is a comprehensive, interpretive report on the feasibility study (FS) portion of the recent remedial investigation/feasibility study (RI/FS) activities conducted on the 4th Operable Unit (OU) at the site. This report was prepared for EPA by Metcalf & Eddy | AECOM (M&E) under the Response Action Contract (RAC). The FS was undertaken utilizing the remedy selection process with the goal of selecting remedies that are protective of human health and the environment, that maintain protection over time, and that minimize untreated waste. This report describes the process used to develop preliminary alternatives and includes a detailed evaluation and comparative analysis of these alternatives for groundwater and sediment. Surface water is also discussed due to its relationship to both groundwater and sediment; however, as will be summarized in Section 1.5, evaluation of surface water did not result in a determination of unacceptable risk at the site and does not require remedial action.

1.1 SITE STUDY AREA

The Iron Horse Park Superfund Site occupies approximately 553 acres in North Billerica, Massachusetts, near the Tewksbury town line, approximately 20 miles northwest of Boston (Figure 1-1). The site is bounded on the north by the B&M railroad tracks, on the west by High Street and an auto auction facility, on the east by Gray Street, and on the south by a wetland, Pond Street, and the Middlesex Canal (Figure 1-2). The on-site areas of concern include the B&M Railroad Landfill, the Reclamation Services, Inc. (RSI) Landfill, the B&M Locomotive Shop Disposal Areas (A and B), the Old B&M Oil/Sludge Recycling Area, the Contaminated Soils Area, the Asbestos Landfill, the Asbestos Lagoons, Shaffer Landfill, B&M Wastewater Lagoons, and the Site-Wide Surface Water and Sediment Contamination. The Middlesex Canal flows through the site to the east, where it joins Content Brook at the southeastern edge of the

Shaffer Landfill. It then flows to the Shawsheen River and ultimately to the Merrimack River to the north. There are abundant wetlands and forested areas at the site. Approximately 20% of the site is forested, while 17% is wetland habitat. In addition, several large wetland complexes border the site, which increase the total acreage of the wetlands at the site to 266 acres. Groundwater in both the overburden and bedrock aquifers generally enters the site from the southwest and flows to the northeast. Similarly, surface water flows onto the site from the south and flows to the northeast, where it converges with B&M Pond and associated wetlands. Based on seepage meter, staff gauge, and mini-piezometer results summarized in the RI/FS, the potential for groundwater to discharge to surface water is evident throughout most of the site.

The site is divided into four operable units (OUs). OU-1 is the Boston & Maine (B&M) Wastewater Lagoons, OU-2 is the Shaffer Landfill, and OU-3 was originally the remainder of the site, including an active industrial complex (the Iron Horse Industrial Park), a railyard, numerous manufacturing operations, open storage facilities, landfills, and lagoons. Investigational activities, including a baseline ecological risk assessment (BERA) and baseline human health risk assessment (HHRA), were completed for OU-3 in 1997. At the time of the FS for OU-3, completed in 2004, it was decided that site-wide surface water, sediment, and groundwater required additional investigation and the OU-3 FS was then limited to site source areas. Therefore, OU-4 includes residual groundwater, surface water, and sediment contamination following the source control measures that will be implemented for OU-3. It should be noted that groundwater associated with Shaffer Landfill (OU-2) is not included as part of the OU-4 evaluation.

The previous investigations described in the OU-3 RI/FS established that the concentrations of some groundwater contaminants exceed applicable or relevant and appropriate requirements (ARARs) or contribute to risk in excess of regulatory guidelines. Additional groundwater studies conducted as part of the OU-3 RI/FS included groundwater modeling, which utilized site-specific information such as boring logs, slug tests, water levels from monitoring wells and staff gauges, and stream seepage tests to simulate groundwater migration and estimate relative times to achieve remedial action objectives (RAOs) for groundwater cleanup. The modeling indicated that, in

most cases, the time to reach RAOs was far greater than 30 years. As a result, EPA decided to address potential groundwater cleanup by initially performing source control measures, then monitoring groundwater and evaluating trends in contaminant concentrations that result from those actions.

Based on the results of the OU-3 HHRA and BERA, M&E was charged with conducting additional investigative activities in site wetlands and ponds, preparing a focused ecological risk assessment/wetland remedial investigation addendum (ERA/WRIA), performing additional monitoring well installation and groundwater sampling activities, and preparing a focused FS for the site (OU-4) in order to support selection of a remedy to control ecological risks to the environment and to supplement the RI (M&E, 1997) and FS (M&E, 2004) for OU-3.

Surface water and sediment supplemental characterization was initiated in 2004, with a data evaluation report (M&E, 2005) and an ERA/WRIA (M&E, 2006a) generated. Supplemental groundwater characterization was performed in 2005 and 2006, with a data evaluation report generated (M&E, 2006b). An additional supplement to the groundwater data evaluation report was also generated in 2008 (M&E, 2008).

1.2 SITE BACKGROUND

This section describes previous investigations and summarizes information on the site and its history.

The site contains an active industrial complex, called the Iron Horse Industrial Park, and a rail yard with a long history of activities that have resulted in contamination of soils, groundwater, surface water, and air. The site includes numerous manufacturing operations, open storage areas, landfills, and lagoons, some of which began operating in the early 1900s. Changes in physical characteristics of the site have occurred during the years of operation, due to the operation and expansion of several landfills, open storage areas, and lagoons. Contaminants known to have

been disposed of at the site include asbestos, polychlorinated biphenyls (PCBs), solvents, waste oils, and other chemicals (CDM, 1987) and are discussed in Section 1.2.1 in relation to the OU-3 areas of concern. Details of groundwater, surface water, and sediment contamination nature and extent are presented in Section 1.4. Discussions of the OU-3 HHRA and BERA are presented in 1.5.1 through 1.5.4.

1.2.1 Site History

Several recent reports provide information on the site related to operational and regulatory history, field investigations, and sampling results. This section of the FS provides a relatively brief narrative of the site history, while Table 1-1 presents a chronology of activity within the site boundaries.

The site was first purchased by the B&M Railroad (now known as PanAm Railways) in 1911. Since 1911, a variety of industrial disposal practices have resulted in the creation of numerous lagoons, landfills, and open storage areas. The B&M Railroad began operations at the site in 1913, including the operation of an oil and sludge recycling area beginning sometime prior to 1938. The B&M Railroad operated the site's sewage collection system between 1924 and 1992. The system included subsurface sewer lines, a dismantled pump house, two unlined filter lagoons, and one overflow lagoon. These wastewater lagoons are OU-1 of the site. In addition to septic wastes, the lagoons also received industrial/hazardous wastes such as solvents, waste oils, and other chemicals from various floor and yard drains found throughout the industrial park. Sludge from the bottom of these lagoons was periodically dredged during the last 60 years of operation and deposited in piles adjacent to the lagoons. The system has been replaced with a public sewer system.

In 1944, the B&M Railroad sold land in the western portion of the site to Johns Manville Products Corporation, which at that time began to manufacture structural insulating board that contained asbestos. Three unlined lagoons were built to dispose of the resulting asbestos sludge

waste. The B&M Railroad also leased land in the eastern portion of the site to Johns Manville to be used as a landfill for asbestos sludge and other asbestos mill wastes generated by their manufacturing operations. EPA capped this landfill in 1984.

In 1961, the Johns-Manville Products Corporation sold the western portion of its land to the General Latex and Chemical Corporation, which manufactured acrylic and vinyl acetate polymers and copolymers used in fabrics, paper, and insulation. The liquid filtrate from the latex and polymerization wastes was discharged to the ground through sand filters. This practice was discontinued in May 1982, when General Latex was connected to the Billerica sewer system.

In 1966, the B&M Corporation sold 106 acres of land north of the Middlesex Canal and east of Pond Street to Phillip Shaffer. This land later became the Shaffer Landfill and is currently OU-2 of the site. This landfill received commercial and residential waste materials from private clients, wastewater treatment sludge from the town of Billerica, and domestic waste from Billerica residents. The landfill stopped receiving waste in April 1986. The Potentially Responsible Parties (PRPs) completed construction of the remedy for the landfill in 2003.

According to 1969 aerial photographs, the B&M Corporation was using a parcel of land located east of the railyard on the south side of the Middlesex Canal as a borrow pit for sand and gravel. This area was leased by B&M Corporation to Reclamation Services, Inc. (RSI) for use as a landfill to dispose of municipal and light industrial waste. In 1976, the B&M Corporation sold approximately 150 acres of primarily developed land to the Massachusetts Bay Transportation Authority (MBTA), which has since used the land to operate passenger rail service. The B&M Corporation now leases much of this land from the MBTA.

M&E finalized the RI for OU-3 in 1997. RI sampling data collected between June 1993 to August 1995 for groundwater, surface soil, subsurface soil, surface water, and sediment from nine potential source areas within the site (the B&M Railroad Landfill, B&M Locomotive Shop Disposal Areas, the RSI Landfill, the Old B&M Oil/Sludge Recycling Area, the Contaminated

Soils Area, the Asbestos Landfill, the Asbestos Lagoons, and Site-Wide Surface Water and Sediment Contamination) indicates the presence of contaminants.

Two separate Records of Decision (ROD) address soil contamination at OU-1 (B&M Lagoons) and OU-2 (Shaffer Landfill). For OU-1, the completed remedy included the excavation of contaminated soils and sludge, and off-site treatment via asphalt batching. The implemented remedy for OU-2 included reconstruction of a landfill cap over the 60 acres, maintenance and monitoring of the landfill gas and leachate collection systems, and continued monitoring of groundwater and surface water quality. The ROD for OU-3 selected source control remedies to address the remaining surface soil contamination across the site. The ROD for OU-4 is planned to address site-wide groundwater, surface water, and sediment, including the wetland areas of the site.

The following sections briefly describe contamination previously detected at the OU-3 source areas of concern and in groundwater near those source areas. See Figure 1-2 for the locations of each source area.

B&M Railroad Landfill. The B&M Railroad landfill is approximately 14 acres in size and is located in a wetland area, north of the Middlesex Canal and east of the railyard. The wetland was filled in by the B&M Railroad and used to dispose of various kinds of debris. Heavy metal concentrations in surface and subsurface soils were higher than background soils. For soils, the southeastern half of the landfill was more contaminated with both organic compounds and metals. High concentrations of PCBs in subsurface soils suggest that PCB materials, possibly oils, were disposed of. Aromatic volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAHs), and petroleum hydrocarbons are indicative of petroleum-related products that probably include coal tar and creosote waste. In groundwater, wells located in the landfill exhibited the highest concentrations of contaminants, especially organic compounds. Aromatic and chlorinated VOCs, PAHs, pesticides, PCBs, and elevated metal concentrations were measured in groundwater, but concentrations were considerably lower than in soil. Although no non-aqueous

phase liquids (NAPLs) were found, oily sands were observed at several depths, and in conjunction with the types of organic compounds detected, suggests evidence of NAPL. Degradation of trichloroethene (TCE) is evidenced by the presence of its potential byproducts, including several forms of dichloroethene (DCE).

Since organic materials prevalent in soils, PCBs, PAHs, and pesticides are not expected to migrate appreciably in the unsaturated zone. It is also expected that the mobility of metals will be limited due to adsorption and other processes in soil. A migration pathway for VOCs in the unsaturated zone may be via vapor phase, since VOCs were detected more often at the top of the water table (in groundwater screening locations) than with depth below it.

With the exception of VOCs, most contaminants found in the saturated zone (pesticides, PCBs, PAHs, phthalates, and heavy metals) will not migrate significantly in the dissolved phase as evidenced by the groundwater quality in wells across from B&M Pond. The presence of PCBs and pesticides below the limits of the waste indicate that residual or pooled dense non-aqueous phase liquid (DNAPL) may be present, although none was observed. Groundwater levels and analytical data indicate that groundwater is migrating vertically. Contaminants in the dissolved phase may migrate from the landfill to the B&M Pond to the east and the Middlesex Canal to the south as evidenced by downgradient contamination. Measured vertical gradients indicate that groundwater from this area discharges to the Middlesex Canal and B&M Pond.

RSI Landfill. The 6-acre RSI Landfill, located east of the B&M railyard near the Johns-Manville Asbestos Landfill, is bounded on the south by an unnamed brook (AUnnamed Brook®) and on the east by a wetland, which is drained by the Middlesex Canal. Waste and fill present in the west-central portion of the landfill include organic compounds and heavy metals detected in subsurface soils, and pesticides, PCBs, and phthalates that were also found in surface soils. Aromatic VOCs, pesticides, and PCBs were detected in groundwater at low concentrations. The detection of chlorinated VOCs in upgradient, as well as downgradient and vicinity wells, indicates that upgradient sources may be affecting groundwater quality. The presence of elevated vinyl chloride

and dichlorinated VOCs directly downgradient of landfilled wastes and near the top of the water table (groundwater screening locations) are indicative of the degradation of wastes. It appears that the aromatic VOCs found in a groundwater cluster near the Johns-Manville Asbestos Landfill are not related to the RSI Landfill, since this well cluster is most likely hydrogeologically affected by the Asbestos Landfill.

Borings indicate that wastes were deposited above and below the water table. The absence of a low-permeability cover allows for contaminant transport from the unsaturated to the saturated zone. Similar to the B&M Railroad landfill, relatively elevated concentrations of PCBs, PAHs, and phthalates are found in the unsaturated zone. These compounds may be highly attenuated through adsorption in percolating water. Although these compounds may also migrate vertically in DNAPL form, no DNAPL was observed. Most metals are fairly immobile due to adsorption and low solubility; however, leaching is possible. Chlorinated VOCs (dichloroethene and vinyl chloride) detected in groundwater screening samples indicate the partitioning of these compounds to the vapor phase. Therefore, vapor phase movement may be a prominent transport mechanism at the water table.

Most organic compounds, with the exception of VOCs, are not likely to migrate significantly in the dissolved phase. Pesticides, PAHs, phthalates, and PCBs adsorb to organic matter in soils. However, due to the presence of more sandy soils, contaminant transport is of greater concern. Based on the direction of groundwater flow, contaminants in the dissolved phase will likely migrate toward the Middlesex Canal to the northeast. Although vertical gradients are low, the presence of pesticides and PCBs in the deep overburden and bedrock groundwater indicates the potential for localized DNAPL pools; however, this was not confirmed during the field activities. The existence of shallow bedrock facilitates contaminant transport from the overburden to bedrock. Hydraulic conductivities suggest that bedrock is more highly fractured in this area of the site. Horizontal hydraulic gradients vary only slightly with lithologies, and the vertical gradients are minimal. In the vicinity of this landfill, there is evidence that groundwater may be discharging to the Unnamed Brook at some locations, while in at least one location, the brook appeared to be

losing water to groundwater.

B&M Locomotive Shop Disposal Areas. The B&M Locomotive Shop Disposal Areas consist of two disposal areas (A and B) separated by a manmade channel that flows into the Unnamed Brook. Heavy metals and organic compounds including pesticides, PAHs, and petroleum hydrocarbons were detected in surface and subsurface soils in both areas, where waste or fill material was found. A few organic compounds (including one VOC, a few pesticides, and one PCB Aroclor) and heavy metals were detected in groundwater in the downgradient and vicinity wells. The detection of organic compounds and some heavy metals in the upgradient cluster indicates that other sources may be present in the vicinity. Mercury and copper were the only detected metals that were not found in the upgradient wells.

The borings indicate that wastes exist above and below the water table. PAHs were found in the highest concentration, especially in subsurface soils, with lower concentrations of pesticides, PCBs, VOCs, and petroleum hydrocarbons. The absence of a low-permeability cover allows for contaminant transport from the unsaturated to the saturated zone. However, pesticides, PCBs, and PAHs in percolating water may be highly attenuated through adsorption to organic matter in the soils.

Aromatic VOCs, PAHs, and petroleum hydrocarbons were notably absent in groundwater, although they were prevalent in subsurface soils. The absence of PAHs may be attributed to adsorption to soils. The absence of aromatic VOCs and petroleum hydrocarbons may be due to the placement of well screens below the water table. The potential for biodegradation of chlorinated compounds is evidenced by the existence of breakdown products of dichloroethene and vinyl chloride near the water table. Based on the direction of groundwater flow, contaminants in the dissolved phase from both areas will migrate toward the northeast with groundwater discharge to the Unnamed Brook. Although vertical hydraulic gradients tend to be downward, there is no evidence that vertical migration of contaminants has occurred at this point.

Only pesticides were detected in surface water in the man-made canal. In contrast, PAHs, pesticides, phthalates, PCBs, and petroleum hydrocarbons were measured in sediments in the canal indicating that adsorption to sediments is occurring. Contaminants in sediments were similar to those measured in surface soils; therefore, overland flow runoff may be contributing to contaminant transport from these disposal areas.

Groundwater flow appears to be towards the north-northeast in both areas. Vertical gradients indicate that the shallow overburden and bedrock are recharging the deep overburden, particularly in Area A, suggesting a preferential flow path. There is potential for groundwater discharge to surface water from both overburden and bedrock. Low stream conductivities may limit discharge.

Old B&M Oil/Sludge Recycling Area. The 6-acre, Old B&M Oil/Sludge Recycling Area was established sometime prior to 1938 for the purpose of recycling oil. Two areas of oil/sludge, located in the northern and southern edges of the area, were found to extend beyond the Penn Culvert fence perimeter. The predominant types of organic compounds found were consistent with the oil/sludge reportedly disposed of in these areas. Contaminants detected in surface and subsurface soils consist primarily of PAHs, long-chain alkanes, and petroleum hydrocarbons. Numerous pesticides and PCBs were detected in the northern area, and heavy metals were measured in both areas. Although aromatic VOCs, PAHs, and petroleum hydrocarbons were generally not present in groundwater, chlorinated VOCs and heavy metals were detected. Heavy metals, which were detected primarily in shallow overburden groundwater, include arsenic, chromium, cobalt, lead, mercury, nickel, and zinc. Petroleum hydrocarbons were measured in one well, and several inches of floating product was observed in one piezometer in the southern oil/sludge area.

Subsurface soils exhibited the highest concentrations of contaminants including aromatic VOCs (benzene, toluene, ethylbenzene, and xylene compounds), PAHs, petroleum hydrocarbons, and elevated metal concentrations. Although some of the area is covered with asphalt, the absence of a low-permeability cover may facilitate contaminant transport to the saturated zone (especially

VOCs). However, PAHs, pesticides, and metals will tend to adsorb to the organic matter (peat) prevalent in soils in this area. Based on observations of free product in the area and the occurrence of PAHs and petroleum hydrocarbons, light non-aqueous phase liquid (LNAPL) in residual or mobile form may be widespread. It was not detected in wells most likely because they are screened as much as 1 foot or more below the water table. The presence of high concentrations of PAHs in subsurface soils may also indicate the presence of DNAPL.

Aromatic VOCs, PAHs, and petroleum hydrocarbons were notably absent in groundwater, although they were prevalent in subsurface soils. The absence of PAHs may be attributed to adsorption to soils. The absence of aromatic VOCs and petroleum hydrocarbons may be due to the placement of well screens below the water table. The potential for biodegradation of chlorinated VOCs is evidenced by the existence of breakdown products of dichloroethene and vinyl chloride at or near the water table.

Groundwater flow directions are to the northeast and east in the shallow overburden, to the east in the deep overburden, and to the northeast in the bedrock. Vertical hydraulic gradients tend to be downward from shallow overburden and upward from bedrock to deep overburden as evidenced by the presence of chlorinated VOCs in the deep overburden. Vertical gradients indicate that deep overburden may be a preferential flow path. The influence of surface water bodies on groundwater flow is minimal in the area.

Contaminated Soils Area. The Contaminated Soils Area is located in the center of the site and is approximately 50 acres in size. Contaminated soil was first identified as a problem in this area after a random soil boring program conducted across the site indicated elevated levels of lead (310 to 76,600 ppm) at nine out of forty locations. Organic compounds, including PAHs, petroleum hydrocarbons, and pesticides, were measured in surface soils in localized areas. Lead and manganese were the heavy metals that were detected most often and in the highest concentrations. No additional analytical data were collected for this area as part of the RI.

Asbestos Landfill. The site has historically been identified with asbestos contamination due to asbestos landfilling operations conducted by Johns-Manville over a 32-year period. Although EPA capped the Asbestos Landfill in 1984, asbestos materials have been found outside the limits of the cap. However, the results of the off-site soil sampling indicated that, with one exception, there were no detectable levels of asbestos in residential areas. No additional analytical data were collected for this area as part of the RI.

Asbestos Lagoons. In addition to the Asbestos Landfill, there are three unlined asbestos lagoons on Johns-Manville property, currently owned by BNZ materials. Surface and subsurface soil samples were not collected during the RI from this area of concern. Groundwater contaminants included VOCs (primarily aromatics and chlorinated VOCs), PAHs, PCBs, and pesticides. Several of the chlorinated VOCs (tetrachloroethene, trichloroethane, and dichloroethane) and heavy metals (arsenic, cobalt, lead, and zinc) were detected in all three flow zones. The types of contaminants found were similar to those detected in the 1980s during investigations related to the Johns-Manville stormwater drainage system. Detected heavy metals and organic compounds were primarily found in downgradient wells near the lagoons.

The limits of waste relative to the water table were not defined, since drilling was not conducted within the lagoons. The predominant types of compounds found in groundwater include pesticides and PAHs, which are likely to strongly adsorb to soils. Concentrations of several metals were elevated, with calcium levels most elevated. This was to be expected due to the plasterboard materials that were disposed here.

Several metals, a few chlorinated VOCs, and PAHs were most prevalent in the deep overburden and bedrock groundwater. PCBs were detected in a shallow well adjacent to catch basins. Past wastewater discharges, stormwater drain leakages, and mounding caused by rainfall likely induced vertical migration of contaminants beneath the area. Low concentrations of pesticides in groundwater may be the result of percolating rainwater. Chlorinated VOCs are likely the most mobile contaminants.

Groundwater in the vicinity of the Asbestos Lagoons is divided with a component of flow to the northwest toward the Middlesex Canal and some flow to the northeast. Groundwater contours indicated the potential for mounding. Vertical gradients tend to be downward from shallow to deep overburden near the lagoons, and upward from bedrock to overburden at the downgradient wells.

Supplemental Groundwater Investigation. During the fall of 2005 and winter of 2005-2006, M&E conducted a groundwater monitoring program at the site. Historical monitoring data were reviewed and a monitoring program was established to provide a current Asnapshot® of existing groundwater conditions at the site. Fifteen new monitoring wells were installed to fill data gaps identified based on the review of historical monitoring data. A total of 60 monitoring wells were sampled (45 existing wells and 15 newly-installed wells) and analyzed for VOCs, semi-volatile organic compounds (SVOCs), and metals. A subset of these wells were also analyzed for pesticides/PCBs (21 locations) and 1,4-dioxane (15 locations). One LNAPL sample was collected from an on-site piezometer and sent to a laboratory for hydrocarbon fingerprinting analysis.

Conclusions regarding this investigation were presented in two documents (M&E, 2006b; M&E, 2008) and include the following:

- \$ Compared to historical findings reported in the OU-3 RI report (M&E, 1997), there were only minor differences in subsurface geology and groundwater flow direction determined from the investigation.
- \$ In general, the recent monitoring showed that a noticeable contaminant plume is still not evident and that the site continues to have a variety of contaminants distributed throughout the site at relatively low concentrations compared to historical site preliminary remediation goals (PRGs), developed for the original FS report (M&E, 2004), and project

action limits (PALs). In comparing the recent monitoring results to historical results, many of the organic compounds previously detected above historical site PRGs have decreased to concentrations below the PRGs at those same wells. However, samples from some wells have analytes not previously detected. Some of these analytes (*e.g.*, 1,1-dichloroethane and vinyl chloride) are breakdown products possibly resulting from natural attenuation occurring at the site. Since historical detection limits were not as sensitive as those used in the recent sampling round, it is also possible that detection of analytes not previously reported may be attributable to the increased analytical sensitivity.

- \$ Similar to historical monitoring results, arsenic and manganese PRG exceedances were noted across the site. Most concentrations were of similar magnitude to historical results. This confirms that attainment of cleanup goals for metals at the site could take a significant number of years (shown as > 200 years in the 2004 OU-3 FS report).
- \$ LNAPL was not observed in any monitoring locations near or around the Old B&M Oil/Sludge Recycling Area. Furthermore, monitoring results did not show contaminant concentrations indicative of an LNAPL source. It is possible that the historically-observed LNAPL is no longer in the area, due to either migration or possible removal during construction activities, or that the current monitoring network does not intersect with the LNAPL. However, LNAPL was observed in a piezometer at the B&M Railroad Landfill. Hydrocarbon fingerprinting resulted in the determination that the LNAPL is No. 6 Fuel Oil. With respect to the possible presence of DNAPL in some site areas, chlorinated hydrocarbons were detected in deep overburden and bedrock locations, but not at concentrations which would be indicative of a significant source.
- \$ 1,4-Dioxane was detected in 6 out of 15 locations at the site. However, the maximum detection was 2.9 µg/L, which is less than the state guideline of 3 µg/L (the site PAL). 1,4-Dioxane is known to be associated with releases of chlorinated solvents, particularly 1,1,1-trichloroethane (TCA). The low concentrations of both 1,4-dioxane and chlorinated

solvents are consistent with the hypothesis that much of the site contamination by chlorinated solvents is likely due to smaller spills/releases across the site, rather than any significant releases. Based on the available data, these concentrations also indicate that 1,4-dioxane is not likely to be a significant site contaminant.

\$ Evaluation of model information and estimated remediation time was reviewed during the supplemental evaluation. The model efforts used were reasonable and it is not likely that a new or updated version(s) would yield changes in the results or uncertainties associated with it.

1.2.2 Previous Studies and Reports

Several studies were conducted at the site prior to the initiation of the OU-4 investigations. These studies have generated reports and maps concerning the site. Some of the studies are listed below:

- NUS Corporation (NUS). 1975. *Final Report for Iron Horse Park Site Inspection, North Billerica, MA*
- Ecology and Environment. 1982. *Field Investigations of Uncontrolled Hazardous Waste Sites (FIT Project): Scope of Work for Site Inspection and Investigation, Iron Horse Park, Billerica, MA*
- NUS Corporation (NUS). 1983. *Preliminary Site Assessment of the Iron Horse Park Facility, North Billerica, MA*
- GHR Engineering Corporation. 1984. *Final Environmental Impact Report, Pond Street Sanitary Landfill, Billerica, MA*
- GHR Engineering Corporation. 1985. *Supplemental Final Environmental Impact Report, Pond Street Sanitary Landfill, Billerica, MA*
- Camp Dresser and McKee (CDM). 1987. *Draft Phase 1A Remedial Investigation for the Iron Horse Site, Billerica, MA*
- Goldberg, Zoino, and Associates (GZA). 1987. *PCB Investigation Report,*

Manville Corporation, North Billerica, MA

- Camp Dresser and McKee (CDM). 1988. *Draft Phase 1B Remedial Investigation for the Boston and Maine Wastewater Lagoon Area, Iron Horse Park Site, Billerica, MA*
- GHR Engineering Corporation. 1988. *Supplemental Hydrogeologic and Water Quality Assessment at the Pond Street Landfill, Billerica, MA*
- Camp Dresser and McKee (CDM). 1989b. *Draft Phase 1C Remedial Investigation for the Shaffer Landfill, Iron Horse Park Site, Billerica, MA*
- Weston Environmental (Weston) 1989. *Wetland Characterization and Biological Investigations, Iron Horse Park Site, Billerica, MA*
- Camp Dresser and McKee (CDM). 1991. *Final Draft Phase 1C Feasibility Study for the Shaffer Landfill, Iron Horse Park Site, Billerica, MA.*
- Metcalf & Eddy (M&E). 1994. *Hydrogeological Assessment Report. Iron Horse Park Superfund Site. 3rd Operable Unit. North Billerica, Massachusetts.*
- Metcalf & Eddy (M&E). 1997. *Remedial Investigation Final Report - Iron Horse Park Superfund Site, 3rd Operable Unit, North Billerica, Massachusetts.*
- Metcalf & Eddy (M&E). 2004. *Feasibility Study Final Report, Iron Horse Park Superfund Site, 3rd Operable Unit, North Billerica, Massachusetts.*

1.3 SITE CHARACTERISTICS

This section discusses the geographic setting, geology, and hydrogeology of the site.

1.3.1 Geographic Setting

The site is located in North Billerica, Massachusetts, approximately 8 miles south of the New Hampshire border, at an elevation of about 115 feet above sea level. The climate is seasonally variable. Based on data collected from 1961 to 1990, the average minimum and maximum daily temperatures at nearby Lowell are 49 °F and 60 °F, and the site receives 42 inches of precipitation

annually (Owenby and Ezell, 1992).

Located in eastern Massachusetts, the site is on the western side of the Seaboard Lowland section of the New England physiographic province, a subdivision of the Appalachian Highlands. The Seaboard Lowlands are characterized by extensive glacial outwash and till deposits overlying a complex of igneous and metamorphic rocks (Castle, 1959).

The site lies on the western edge of the Shawsheen River drainage basin and is approximately 1.5 miles from the northward-flowing Shawsheen River. The site is surrounded by upland areas on the southeast side, including several small forested hills near Pond Street, and low lying wetland areas on the western, northern, and northeastern sides of the site. Currently, 17% of the site is characterized as wetlands (M&E, 1995).

Soils on and in the immediate vicinity of the site are classified as predominantly urban land with other soil types to a lesser extent. These soil types are described in detail in Section 3.1.3 of the final RI Report (M&E, 1997). Urban land is indicated in areas where the soil has been disturbed or altered, is obscured by cultural features (*e.g.*, buildings, industrial areas, roads, rail yards) and where these features cover more than 75% of the surface area.

The site is used for industrial purposes, with no residential use. The Middlesex Canal is essentially impassable for recreation or economic purposes. Some parts of the site are fenced, but most is accessible to passers-by. The area within one mile of the site boundary is primarily forest and residential, consisting primarily of single-family residential properties.

Surface waters in the vicinity of the Shaffer Landfill are classified as Class B waters by the Commonwealth of Massachusetts and are designated for use as warm water fisheries and contact recreation (CDM, 1991). The Middlesex Canal, linking the Merrimack River to the Boston basin, runs through the site, and some of its original features remain. Histories of the canal indicate that clay was used along the canal banks to limit seepage of the canal water into neighboring lowlands

(Clarke, 1974). However, use of the clay liner in the canal may have been limited in extent.

A town inventory of historical properties revealed two historical assets within the site boundaries (CDM, 1987). The Small Pox Cemetery, dating back to 1811, is located between the Middlesex Canal and the MBTA commuter railroad line. The Content Brook Mill is located at the eastern end of the Shaffer Landfill property.

Files on five historic locations within or adjacent to the site are maintained by the Massachusetts Historical Commission (MHC). These include the Pond Street Bridge over the B&M Railroad at the site boundary (inventoried as BIL.917), the B&M Railroad Billerica Shop Complex (BIL.299), the Equipment Storage Shed (BIL.300), the Maintenance Shed (BIL.301), and the Power Plant (BIL. 302), the last four being centrally located on the site. These buildings were constructed between 1911 and 1914, and each was recommended as eligible for the National Register during the MBTA Historical Property Survey conducted in 1988, as noted in MHC files.

As shown in Figure 1-3, part of the site overlies what is expected to be a medium-yield aquifer. The remainder is expected to be a low-yield aquifer. No public water supply sources are located within the medium-yield aquifer on the site. As shown on the figure, most of the groundwater beneath the medium-yield aquifer is considered a non-potential drinking water source by the Commonwealth of Massachusetts, but some areas were not included as part of this designation, primarily those with limited use/vehicular traffic.

Although not currently in use, community public water supply wells are located less than one mile east of the site in Tewksbury. The Interim Wellhead Protection Area (IWPA) for one of the Tewksbury wells previously extended to within approximately 500 feet of the site on the northeast side, but has since been reduced in size due to well inactivity. Surface water and other groundwater community public water supplies are located at North Billerica on the Concord River, just north of the Route 3A bridge, where a filtration plant is located. Similar to the historical public water supply wells in Tewksbury, the North Billerica well is no longer in use and

its associated IWPA has been reduced in size.

There may be private wells along Gray Street, which is east of the Shaffer Landfill section of the site, based on the knowledge of personnel at the Billerica Health Department (M&E, 1996).

There may also be some private wells to the north of the site in the Burnham Road area. The town of Billerica does not maintain records for these wells, if they do exist. It is not known whether any such private wells are used as sources of drinking water or for other domestic uses.

1.3.2 Geology

Bedrock underlying the site is comprised of granite, schist, and diorite. Bedrock surface elevations suggest the presence of a trough in the bedrock surface trending northeast from the Old B&M Oil/Sludge Recycling Area to the Unnamed Brook, then northwest toward the Asbestos Lagoons. Bedrock fractures were found trending north-northeast and east-west.

The overburden primarily consists of glacial drift deposits including basal and ablation till and glacial outwash deposits. Basal till was found primarily on the southwestern portion of the site, and ablation till was found primarily in the western and southern portions of the site overlying basal till. Glacial outwash deposits were encountered throughout the site. Peat deposits were encountered underlying fill materials near streams, ponds, and wetlands at the site.

1.3.3 Hydrogeology

As noted in the OU-3 RI report (M&E, 1997), groundwater in both the overburden and bedrock aquifers generally enters the site from the southwest and flows to the northeast. Similarly, surface water flows onto the site from the south and flows to the northeast, where it converges with B&M Pond and associated wetlands. Surface water flows off site by way of a series of wetlands (wetland complex) that has developed over time around the Unnamed Brook and its confluence with Middlesex Canal. Based on seepage meter, staff gauge, and mini-piezometer results, the

potential for groundwater to discharge to surface water was evident throughout most of the site.

1.4 NATURE AND EXTENT/FATE AND TRANSPORT

The following sections discuss the nature and extent of contamination in groundwater, surface water, and sediment at the site, based on two sets of sampling results for each medium: 1993 and 2004 (surface water/sediment); and 1995 and 2005/2006 (groundwater). The surface water/sediment data and the groundwater data are discussed separately in Sections 1.4.1 and 1.4.2, respectively. The sources of contamination in the environmental media are primarily attributed to past disposal activities at the site. Contaminant fate and transport are described in Section 1.4.3.

1.4.1 Surface Water and Sediment

The following sections discuss the nature and extent of contamination in surface water and sediment at the site, based on both the 1993 and 2004 sampling results. The 1993 and 2004 data sets are discussed separately in Sections 1.4.1.1 and 1.4.1.2, respectively. Further details on sampling results may be found in the OU-3 RI Report (M&E, 1997) and ERA/WRIA (M&E, 2006a).

1.4.1.1 1993 Sampling Data. Surface water and sediment sampling locations (see Figure 1-4 from 1997 BERA) were situated in different environmental settings across the site, ranging from free-flowing channels in the Middlesex Canal and Content Brook, to emergent wetland environments in Richardson Pond, to a small almost stagnant channel in the Unnamed Brook. The chemical characteristics of the surface water bodies varied due to the differing environmental settings, as well as differences in nearby activities.

Surface Water. Organic compounds and elevated metal concentrations were detected in surface water locations across the site during 1993. The dominant types of organic compounds detected

consist of aromatic and chlorinated VOCs, PAHs, phenolic compounds, and pesticides. While petroleum hydrocarbons were not detected in any of the surface water locations, PCBs were detected only in September 1993 at two locations. For the most part, more organic compounds were detected in June 1993 than in September 1993. In all, organic compounds were found at 35 surface water locations in June 1993 and at 22 locations in September 1993, with at least one organic compound detected in one or more surface water locations from each of areas sampled during one or both sampling rounds. The same types of organic compounds and metals detected in surface water were also found in soils from the various source areas in the industrial park, as well as soils and groundwater from nearby areas.

During both sampling rounds, aromatic VOCs were found in locations east of Pond Street, and at Richardson Pond and the Shaffer Landfill Wetlands. Chlorinated VOCs were primarily associated with the surface water location in the sedimentation pond south of the RSI Landfill. To a lesser extent, chlorinated VOCs were also detected in nearby surface water locations in the RSI Wetland Area, the Middlesex Canal associated with the B&M Pond, and the Unnamed Brook. Phenolic compounds and PAHs were detected in locations neighboring railroad tracks, roads, and Shaffer Landfill. These types of organic compounds were more prevalent in June 1993 than in September 1993. Pesticides were also more frequently detected in June 1993. Sixteen pesticides were identified in June 1993, compared to the eight identified in September 1993. Pesticides, as well as PAHs, were also present in at least one of the background surface water locations (collected from Wetland 10 and Wetland 11 as depicted on Figure 1-4). The presence of pesticides was widespread, with at least one compound detected at 29 of the surface water locations. However, concentrations were indicative of residual levels, which are most likely adsorbed to particulates in the water column. Likewise, the infrequent detections of PCBs at relatively low concentrations suggest that the PCBs are being adsorbed to particulates.

In addition to major metal ions, metals were commonly found at many of the surface water locations as well as at background surface water locations during 1993. In total, manganese and 13 other metals were found. In particular, elevated concentrations of chromium, copper, lead,

manganese, vanadium, and zinc were found across the site. Although there were no distinct trends, surface water in the Shaffer Landfill Wetlands east of the landfill exhibited the most elevated metal concentrations and specific conductances.

In general, the surface water locations where more organic compounds as well as elevated metal concentrations were consistently measured include the southwest corner of Richardson Pond (adjacent to the commuter rail line tracks and the bottom of the Pond Street embankment), Shaffer Landfill Wetland locations, one location in Content Brook, and the sample collected at the base of a discharge pipe in the sedimentation pond off the Unnamed Brook.

Sediment. During June 1993, a total of 46 site-wide sediment locations were sampled. Only 43 sediment locations were sampled during September 1993 because of dry conditions at three locations. As with surface water, organic compounds and elevated metal concentrations were detected at sediment locations across the site. Background sediment (collected from Wetland 10 and Wetland 11 as depicted on Figure 1-4) displayed chemical characteristics similar to those of associated surface water. The primary organic compounds detected in background sediment were PAHs and pesticides, both of which are common to residential and industrialized areas. In addition, the types of metals found at background locations include arsenic, chromium, cobalt, copper, lead, mercury, vanadium, and zinc.

The most prevalent types of organic compounds found in site-wide sediments were PAHs, petroleum hydrocarbons, pesticides, and PCBs. Volatile organic compounds (aromatic and chlorinated) were also commonly found, but less often and in lower concentrations. Aromatic VOCs were more prevalent in June 1993 than in September 1993 and were found at more locations and at higher concentrations than chlorinated VOCs. Aromatic VOCs (BTEX compounds and chlorobenzene) were detected at 14 sediment locations, most of which are scattered throughout the geographical location groupings, east of Pond Street. Chlorinated VOCs were primarily detected in June 1993 at three locations, all of which were east of Pond Street. In contrast, chlorinated VOCs were not present in the sediment sample collected from the

location within the sedimentation pond where elevated chlorinated VOC concentrations were found at the corresponding surface water location.

In comparison, PAHs and pesticides were more widespread than VOCs, occurring in as many as 44 sediment locations. Like VOCs, PAHs and pesticides tended to be detected more frequently and in higher total concentrations in each location in June 1993 compared to September 1993. Multiple PAHs and pesticides were identified at most of the locations. For PAHs, the highest concentrations were usually reported for the larger, more substituted compounds. In addition, petroleum hydrocarbons and other fuel/petroleum-related combustion compounds (*e.g.*, dibenzofuran, phenolics, carbazole) generally occurred at sediment locations where PAHs were prevalent. For pesticides, the DDT group was detected more frequently and at higher concentrations than other pesticides. Of the 20 pesticides identified in June 1993, only seven were reported in September 1993. Both PAHs and pesticides were also present in background sediment locations.

Although PCBs were not as widespread as PAHs and pesticides, as many as six Aroclors were identified at 29 sediment locations in June 1993. In comparison, one Aroclor (1248) was found at three of the 29 locations in September 1993. The highest concentrations occurred at the four sediment locations in the northern portion of the Middlesex Canal, which is west of Pond Street and directly north of the Asbestos Lagoons. PCB contamination in this portion of the canal, as well as in the stormwater drain system, wells, and soils in the vicinity of the canal and the BNZ facilities that are south of the Asbestos Lagoons (see Figure 1-2), has been historically documented since 1986 (CDM, 1987; GZA, 1987). A summary of the PCB contamination in this area is summarized in the PCB Contamination Evaluation Report (M&E, 1994). Although PCB-contaminated sludge and sediment from the stormwater catch basins was removed in 1986 (GZA, 1987), previous findings indicated that sediments in this section of the canal remained contaminated, with individual Aroclor concentrations as high as 2,000 µg/kg. Additionally, PCBs were found in June 1993 at one location within four other geographical groupings: B&M Pond, Richardson Pond, Shaffer Landfill Wetlands, and the man-made canal near the B&M Locomotive

Shop Disposal Areas.

In addition to major metal ions, beryllium, barium, manganese, and 13 other metals were detected in sediments across the site. Arsenic, lead, and zinc were among the metals detected most often and at more elevated concentrations than those found in the background sediments.

The sediments in the Asbestos Lagoons exhibited different chemical characteristics. The three unlined trenches located on BNZ property were used until 1985 for the disposal of a 50% liquid asbestos slurry from the Johns-Manville manufacturing operations. Currently, the solidified asbestos slurry is exposed in the two end lagoons. The central lagoon is covered with topsoil/fill and sparse vegetation. The samples collected from the lagoons consisted of a solidified asbestos slurry in the form of a dry, white chalky-fibrous material. No other waste material, staining, or discoloration was observed in the lagoons.

A few organic compounds including two VOCs, one phthalate, and one PAH were each detected once in Asbestos Lagoon sediments. In comparison, several pesticides were detected at the four sampling locations. Since the samples collected represent surficial conditions and pesticides are not associated with the manufacturing operations, the presence of pesticides have likely resulted from large-scale spraying of the general area.

Metal concentrations were generally similar between individual samples from the Asbestos Lagoons. While several metals were present, calcium concentrations were substantially elevated in comparison to other metals. This is attributed to the fact that calcium-enriched minerals are typically major components of plasterboard.

1.4.1.2. 2004 Sampling Data. Based on the results of the OU-3 BERA, supplemental sampling in the wetland areas of the site was conducted to support the ERA/WRIA. Surface water, sediment, and fish sampling locations are shown on Figures 1-5, 1-6, and 1-7.

Surface Water. Surface water samples were collected at five locations corresponding to where fish sampling was to occur, including Richardson Pond (SW-RP samples), Content Brook (SW-CB samples), West Middlesex Canal (SW-MC samples), B&M Pond (SW-BM samples), and Round Pond (SW-RF reference samples). Surface water samples were analyzed for toxicity, as well as in triplicate for total and dissolved metals and alkalinity. Surface water toxicity tests were conducted on daphnid (*Ceriodaphnia dubia*) and minnow (*Pimephales promelas*) (see Table 1-2).

The additional surface water samples collected in 2004 indicated elevated concentrations of both total and dissolved barium and manganese in each surface water body, including the reference location. Surface water analytical results from 2004 are presented in Table 1-3, with comparison to benchmarks presented in Table 1-4. Dissolved aluminum, arsenic, lead, and zinc were also detected in surface water. Content Brook was the area from which most of the maximum detected metals concentrations were detected; maximum detects for both total and dissolved aluminum, barium, manganese, and zinc, dissolved cobalt, and total lead were detected in samples collected from Content Brook. Maximum total and dissolved arsenic, calcium, and magnesium concentrations were detected at Richardson Pond. From B&M Pond, the only maximum detects that were observed were for total copper and dissolved lead.

Fish. Fish samples were collected from four on-site surface water bodies (B&M Pond, Richardson Pond, Middlesex Canal down gradient of the Johns-Manville outfall, and Content Brook) and the reference water body (Round Pond). Fish sampling locations were selected based on habitats that could support fish.

Overall, the highest concentrations of most metals, including aluminum, arsenic, barium, chromium, cobalt, copper and manganese were detected in fish tissue samples collected from B&M Pond. The highest concentrations of lead, silver and zinc were detected in samples collected from Content Brook. The fish tissue samples from the reference pond, as well as Richardson Pond, generally had low concentrations of metals. Samples from the West Middlesex Canal had metals concentrations higher than the reference pond, although concentrations of

chromium, cobalt, vanadium, and zinc were similar to those detected in Round Pond.

PAHs were detected in fish tissue samples collected from all site areas. Overall, the highest concentrations of PAHs were detected in fish from B&M Pond. The highest concentrations of the PAH acenaphthene were found in fish tissue samples collected from B&M Pond, one sample from Content Brook, and one sample from West Middlesex Canal. The maximum phenanthrene concentration was found in a sample collected from B&M Pond. Fish samples collected from the reference location were non-detect or estimated below the detection limit for anthracene, pyrene, and perylene. Two other SVOCs, biphenyl and dibenzofuran, were detected in fish tissue from each site area, but were not detected in the reference fish samples.

Sediment. Sediment sampling locations were selected in 2004 to represent 1993 sampling locations which had shown elevated levels of contamination and based on visual observations made during a site reconnaissance. In most cases, the staked location from historical sampling was located and samples were collected within a few feet of the previously sampled location. If a previous sampling location was not located or if sampling was to occur in a new location, the sediment sampling locations were selected based on where sediment deposition was likely to have occurred. A detailed discussion regarding the selection of sediment sampling locations is provided in Section 2 of the Data Evaluation Report (M&E, 2005).

Field screening was performed on the twenty on-site sampling locations and the three reference locations in order to select four on-site sediment sampling locations to undergo full characterization analysis. Sediment field-screening results for target metals, PAHs, PCBs, and Microtox[®] toxicity are discussed below.

Target Metals Field Screening. Field-screening analysis was performed using X-ray fluorescence spectrometry (XRF) for ten metals for the sediment samples collected, including arsenic, barium, cobalt, copper, chromium, lead, manganese, silver, vanadium, and zinc.

Arsenic was detected in 10 of the 23 sediment samples collected, with results ranging from 40.6 to 334 mg/kg, and detections occurring within at least one sample collected from each area, except the reference location, Round Pond. The highest arsenic concentrations were recorded in sample SED-01 (334 mg/kg) from Content Brook. Three of four samples from Content Brook had detectable arsenic concentrations and Richardson Pond sample, SED-14, also recorded an elevated arsenic concentration (317 mg/kg).

Lead concentrations were detected in 22 of the 23 sediment samples collected. The average lead concentration in sediment was 285 mg/kg. Lead was detected at all areas, including the reference area. The highest concentrations were in samples SED-05 (822 mg/kg) from B&M Pond, SED-11 (929 mg/kg) from West Middlesex Canal, and SED-17 (914 mg/kg) from the Unnamed Brook. The sediment samples from Content Brook and Round Pond, the reference location, contained lead at concentrations less than 200 mg/kg.

Detectable concentrations of barium were recorded in 18 of the 23 sediment samples collected. The detected concentrations ranged between 83.7 and 497 mg/kg, with the highest barium concentration in SED-20 collected from the Unnamed Brook. Copper was detected in 4 of 23 total samples, with detected concentrations between 121 and 930 mg/kg. These samples were collected from B&M Pond, the West Middlesex Canal, and the Unnamed Brook. Manganese was found at detectable concentrations in six sediment samples. The highest manganese concentrations were detected in B&M Pond samples SED-06 and SED-07 (839 and 3,120 mg/kg, respectively). All sediment samples collected from the reference pond contained detectable manganese concentrations (333 to 581 mg/kg). Zinc was detected in 21 of 23 sediment samples, with an average concentration of 370 mg/kg. The highest zinc concentrations were detected at locations SED-05 (3,870 mg/kg) collected from B&M Pond and SED-13 (1,090 mg/kg) collected within the Richardson Pond wetland. Chromium was only detected in sample SED-19 collected from the Unnamed Brook (511 mg/kg). Cobalt, silver, and vanadium were not detected at concentrations above their specific detection limit in any sample.

PAH Field Screening. All PAH results are discussed in dry weight. Total PAH concentrations were detected in all samples, with an average concentration of 51.1 mg/kg in the 23 samples. The highest concentrations were detected in samples SED-05 (161.6 mg/kg) and SED-07 (163.13 mg/kg) from B&M Pond, SED-12 (156.8 mg/kg) from the West Middlesex Canal, and SED-18 (116.84 mg/kg) from the Unnamed Brook.

PAH concentrations were 20 mg/kg or less in Content Brook and at Round Pond, the reference location. Of the four sediment samples from the B&M Pond area, two had total PAHs greater than 160 mg/kg, and the other two samples had total PAH concentrations less than 20 mg/kg. Samples from the West Middlesex Canal had total PAH concentrations ranging between 47.36 and 156.8 mg/kg, with the exception of sample SED-11 (6.1 mg/kg). PAH detections within samples from the Unnamed Brook ranged between 28.24 and 116.84 mg/kg. In Richardson Pond, total PAH concentrations ranged between 7.69 and 59.36 mg/kg.

PCB Field Screening. In all sediment samples, total PCB concentrations were below the detection limit, specific to percent solids of the sample.

Microtox® Screening. The Microtox® results were used in conjunction with the other field-screening analyses to select sediment samples for full characterization analysis, and to also provide evidence for relative sediment toxicity. Microtox® utilizes a bioluminescent bacterium, *Vibrio fischeri*, where a reduction in light output serves as a measure of toxicity, and percent effect, or reduction in light, is quantified at 5 and 15 minutes. The percent effect after the 5 minute time period is representative of acute toxicity, while that after the 15 minute time period serves as a measure of chronic toxicity. Both the 5 minute and 15 minute percent effects are measured against controls. For example, if the measured luminescence of the bacteria was less than that of the control after 5 minutes, the percent effect at 5 minutes would be a positive percent effect. However, if after the 15 minute period there was no difference in the measured luminescence of the same sample as compared to that of the control, the percent effect after 15 minutes would be 0%. Therefore, a sample could have a positive percent effect at 5 minutes, but no percent effect

at 15 minutes. Microtox[®] testing was performed on whole sediment samples.

Use of Microtox[®] screening for sediment samples is supported by a number of studies documenting the consistency of the Microtox[®] results with the results reported of both sediment invertebrate toxicity tests and macroinvertebrate field surveys (Doherty, 2001; Day *et al.*, 1995; Giesy *et al.*, 1988; and Giesy and Hoke, 1989). According to these reports, the Microtox[®] solid-phase test was shown to be sensitive to a variety of contaminants in sediments. Because of differences in modes of action and differences between organisms, bacteria do not respond to all chemicals in the same manner and degree as other forms of aquatic life. For example, bacteria are thought to be sensitive to metals, showing particularly high sensitivity to copper (Giesy *et al.*, 1988). However, Microtox[®] results may display less sensitive to common pesticides and other chlorinated compounds such as PCBs (Giesy *et al.*, 1988). Microtox[®] is also less sensitive to ammonia in sediment pore water than *C. dubia* or *P. promelas*. Because of the differences in the results of microbial assays from those of higher organisms, microbial tests are often used along with other bioassays, as another screening tool and line of evidence for the toxicity of sediments to aquatic organisms.

In two Microtox[®] screening sediment samples collected from B&M Pond and East Middlesex Canal (SED-05 and SED-08, respectively), the highest response (approximately 60% effect) was measured at 5 minutes. SED-05 was selected for full characterization. From the West Middlesex Canal, two sediment samples (SED-10 and SED-11) showed approximately 50% effect at 15 minutes; SED-11 was one of the samples chosen for full characterization. Three of the four samples from Content Brook (SED-01, SED-02, and SED-04) showed percent effects ranging from 28% to 37% at 5 minutes, including SED-01 which was also selected for full characterization. Lower percent effects were observed from samples from the Unnamed Brook (SED-17, SED-18, SED-19, and SED-20), Richardson Pond (SED-13, SED-14, and SED-15), and Round Pond (reference samples SED-21, 22, and 23), with the exception of sample SED-16 from Richardson Pond which showed approximately a 45% effect at 15 minutes.

Full Characterization Results. Five sediment samples were selected for full characterization analyses, including four that were based on either elevated field-screening results (three site samples) or the lowest field-screening result (one reference sample), as well as one location within B&M Pond that had been the location of the highest historical 4,4'-DDD detection. Since the samples were screened for toxicity, PAHs, PCBs, and ten target metals, there were numerous variables to consider within the field-screening results to select samples for full characterization analyses. In addition, a spatial separation of full characterization samples across the site was desired, to better characterize site-wide risks during the ERA/WRIA.

Sediment samples selected for full characterization include SED-01 (within the Content Brook Area), SED-05 (within B&M Pond), SED-11 (within the West Middlesex Canal), SED-18 (within the Unnamed Brook), and SED-22 (within the reference area - Round Pond). The locations of the sediment samples selected for full characterization are depicted on Figure 1-7. No samples were selected from Richardson Pond for full characterization. The rationale for the selection of sediment samples for full characterization is provided in Section 2 of the ERA/WRIA (M&E, 2006a). Historical data, as well as the field-screening results were considered during the selection of samples for full characterization. Samples selected for full characterization were analyzed for grain size, toxicity, and chemical analyses including TOC, target metals, 4,4'-DDD, PCBs, and PAHs.

Full characterization analysis of sediment samples confirmed elevated total PAHs for B&M Pond and the Unnamed Brook, whereas lower concentrations (*i.e.*, comparable to the reference location) were detected for West Middlesex Canal and Content Brook.

Metals field screening indicated detected concentrations of several target metals, including arsenic, chromium, copper, lead, manganese, silver, and zinc in one or more sediment samples. Fixed-laboratory metal analysis of sediment samples collected from B&M Pond indicated the highest concentrations of most metals, except arsenic and manganese. For this location, concentrations of arsenic, barium, chromium, cobalt, copper, lead, and zinc exceeded the

reference metal concentrations by one to two orders of magnitude. Sediment samples collected from Content Brook had the highest concentrations of arsenic and manganese. The lowest metals concentrations of the site locations were detected in the West Middlesex Canal sediment sample. The highest concentrations of 4,4'-DDD, Aroclor-1254 and Aroclor-1260 were detected in the sample from B&M Pond. Lower concentrations of 4,4'-DDD were reported for sediment samples collected from Content Brook and the Unnamed Brook. The reference location indicated a 4,4'-DDD concentration at a comparable level as found in the Unnamed Brook.

1.4.2 Groundwater

The following sections discuss the nature and extent of contamination in groundwater at the site (excluding the OU-2 portion of the site, east of Pond Street), based on both the 1995 and 2005/2006 sampling results. The 1995 and 2005/2006 data sets are discussed separately in Section 1.4.2.1 and 1.4.2.2, respectively.

1.4.2.1 1995 Sampling Data. Groundwater sampling locations are presented on Figure 1-8. In the following sections, historical contaminant distribution is presented for five areas of concern (AOCs), as discussed in the OU-3 RI/FS (M&E, 1997; M&E, 2004). Discussion of surface and subsurface soil is included as it relates to groundwater contaminants detected in each area.

B&M Railroad Landfill. Similar types of organic compounds including VOCs, PAHs, phthalates, petroleum hydrocarbons, and pesticides were detected in surface and subsurface soils, with the highest concentrations occurring in subsurface soils. These contaminants were considerably less prevalent in groundwater. Heavy metal concentrations in surface and subsurface soils were higher than background soils. For soils, the southeastern half of the landfill was more contaminated with both organic compounds and metals. High concentrations of PCBs in subsurface soils suggest that PCB-contaminated material, possibly oils, was disposed of. Aromatic VOCs, PAHs and petroleum hydrocarbons are indicative of petroleum-related products that probably include coal tar and creosote waste.

In groundwater, wells located in the landfill exhibited the highest concentrations of contaminants, especially organic compounds. Aromatic and chlorinated VOCs, PAHs, pesticides, PCBs, and elevated metal concentrations were measured in groundwater, but concentrations were considerably lower than in soil. Although no non-aqueous phase liquids (NAPLs) were found, oily sands were observed at several depths; in conjunction with the types of organic compounds that were detected, this suggests the presence of NAPL. Degradation of trichloroethylene (TCE) is evidenced by the presence of its potential byproducts, including both isomers of dichloroethylene (DCE).

RSI Landfill. Waste and fill present in the west-central portion of the landfill included organic compounds and heavy metals, detected in subsurface soils, and pesticides, PCBs, and phthalates, found in subsurface and surface soils. Aromatic VOCs, pesticides, and PCBs were detected in groundwater at low concentrations. The detection of chlorinated VOCs in upgradient, as well as downgradient and vicinity wells, indicated that upgradient sources may be affecting groundwater quality. The presence of elevated vinyl chloride and dichlorinated VOCs directly downgradient of landfilled wastes and near the water table (groundwater screening locations) were indicative of the degradation of chlorinated VOCs. Aromatic VOCs found in a groundwater cluster near the Asbestos Landfill and the RSI Landfill were most likely from the Asbestos Landfill. The basis for this conclusion is: these wells are located immediately downgradient of the Asbestos Landfill, the contaminant concentrations in these wells were consistent between sampling rounds, and concentrations of aromatic compounds at the levels detected in these downgradient wells were not found elsewhere on-site.

B&M Locomotive Shop Disposal Areas. Heavy metals and organic compounds including pesticides, PAHs, and petroleum hydrocarbons were detected in surface and subsurface soils in both areas, where waste or fill material was found. A few organic compounds (including one VOC, a few pesticides, and one PCB Aroclor) and heavy metals were detected in groundwater in the downgradient and vicinity wells. The detection of organic compounds and some heavy metals

in the upgradient cluster indicated that other sources may be present in the vicinity. Mercury and copper were the only detected metals that were not found in the upgradient wells.

Old B&M Oil/Sludge Recycling Area. Two areas of oil/sludge, located on the northern and southern edges of the area, were found to extend beyond the Penn Culvert fence perimeter, with one area extending onto MBTA property. The predominant types of organic compounds found were consistent with the oil/sludge reportedly disposed of in these areas. Contaminants detected in surface and subsurface soils consist primarily of PAHs, long-chain alkanes, and petroleum hydrocarbons. Numerous pesticides and PCBs were detected in the northern area, and heavy metals were measured in both areas. Although aromatic VOCs, PAHs, and petroleum hydrocarbons were generally not present in groundwater, chlorinated VOCs and heavy metals were detected. Heavy metals, which were detected primarily in shallow overburden groundwater, include arsenic, chromium, cobalt, lead, mercury, nickel, and zinc. Petroleum hydrocarbons were measured in one well, and several inches of floating product were observed in one piezometer in the southern oil/sludge area.

Contaminated Soils Area. Since surface soil contamination was of key concern in this area, this was the only medium sampled. Organic compounds, including PAHs, petroleum hydrocarbons, and pesticides, were measured in surface soils in localized areas. Lead and manganese were the heavy metals that were detected most often and in the highest concentrations. Cyanide was detected in a localized area along the southeastern boundary.

Asbestos Lagoons. Sediment soil samples were collected at these lagoons during the RI. Groundwater contaminants included VOCs (primarily aromatic and chlorinated VOCs), PAHs, PCBs and pesticides. Several of the chlorinated VOCs (perchloroethylene (PCE), TCA, and dichloroethane (DCA)) and heavy metals (arsenic, cobalt, lead, and zinc) were detected in the shallow overburden, deep overburden and bedrock flow zones. The types of contaminants found were similar to those detected in the 1980s during investigations related to the Johns-Manville stormwater drainage system. Detected heavy metals and organic compounds were primarily

found in downgradient wells near the lagoons.

1.4.2.2 2005/2006 Sampling Data. To provide an updated snapshot of the nature and extent of groundwater contaminants at the site, groundwater from fifteen new monitoring wells and 45 existing monitoring wells was sampled during winter 2005-2006. Groundwater monitoring well locations are shown on Figure 1-8.

As presented in the OU-3 RI report (M&E, 1997), the site did not show evidence of any well-defined contaminant plumes. Organic contaminants also did not present themselves at high enough concentrations to be considered hot spots. Metals were similarly distributed across the site without a notable pattern.

The human health risk assessment contained in the OU-3 RI report (M&E, 1997) determined that groundwater contaminants contributing to cancer risk and non-cancer hazards in excess of regulatory guidelines at the site included a variety of VOCs, SVOCs, pesticides/PCBs, and metals. The FS report (M&E, 2004) provided preliminary remediation goals (PRGs) as follows:

\$	benzene - 5 µg/L
\$	1,2-dichloroethane (1,2-DCA) - 5 µg/L
\$	1,1-dichloroethene (1,1-DCE) - 7 µg/L
\$	1,1,2,2-tetrachloroethane - 0.425 µg/L
\$	tetrachloroethene (PCE) - 5 µg/L
\$	trichloroethene (TCE) - 5 µg/L
\$	bis(2-ethylhexylphthalate (BEHP) - 6 µg/L
\$	carbazole - 4.25 µg/L
\$	aldrin - 0.005 µg/L
\$	PCBs - 0.5 µg/L
\$	arsenic (As) - 10 µg/L
\$	beryllium (Be) - 4 µg/L
\$	manganese (Mn) - 300 µg/L ¹
\$	thallium (Tl)- 2 µg/L

¹ Original PRG in OU-3 FS report was 875 µg/L; PRG has been modified to reflect changes to regulatory standards and guidance since that report was published

Also presented in the OU-3 FS report was discussion of the time necessary to achieve the PRGs presented above. Based on modeling simulations, some VOCs were likely to achieve the PRGs in a short amount of time, with or without active remediation, due to their low concentrations. However, the metals, SVOCs, and pesticides were not likely to achieve the PRGs in a reasonable amount of time, even with active remediation. This recent monitoring round provides results 10 years beyond the historical results and allows an evaluation of these modeling conclusions to be performed.

In general, the recent monitoring shows that a noticeable contaminant plume is still not evident and that the site continues to have a variety of contaminants distributed throughout the site at relatively low concentrations compared to site PRGs and PALs. In comparing the recent monitoring results to historical results, many of the organic compounds previously detected above site PRGs have decreased to concentrations below the PRGs at those same wells. However, samples from some wells have analytes not previously detected. Some of these analytes (e.g., 1,1-DCA, and vinyl chloride) are breakdown products possibly resulting from natural attenuation occurring at the site. Since historical detection limits were not as sensitive as those used in the recent sampling round, it is also possible that detection of analytes not previously reported may be attributable to the increased analytical sensitivity.

Table 1-5 provides a well-specific summary of notable detections and observations for the winter 2005-2006 groundwater monitoring round. The table also provides the primary rationale for well selection, based on historical monitoring data, for comparison purposes.

1,4-Dioxane was detected in 6 out of 15 locations at the site. However, the maximum detection was 2.9 µg/L, which is less than the state guideline of 3 µg/L (the site PAL). 1,4-Dioxane is known to be associated with releases of chlorinated solvents, particularly 1,1,1-TCA. The low concentrations of both 1,4-dioxane and chlorinated solvents are consistent with the hypothesis that much of the site contamination by chlorinated solvents is likely due to smaller spills/releases across the site, rather than any significant releases. Based on the available data, these

concentrations also indicate that 1,4-dioxane is not likely to be a significant site contaminant.

In reviewing the site areas of concern (AOCs) (see Figures 1-2 and 1-8 for locations of AOCs and monitoring wells) and with respect to the recent monitoring results, the following observations are noted (monitoring well clusters used for evaluation of each AOC are noted in brackets):

- \$ The Old B&M Oil/Sludge Recycling Area [MW-202, MW-203, MW-301, MW-302, MW-303, and OW-37/38] did not show evidence of LNAPL in MW-303, installed near the destroyed piezometer P-12, which historically showed evidence of LNAPL. Arsenic and manganese were detected in the area above PRGs. It appears that there may have been a release involving carbon tetrachloride after the 1995 sampling events, as evidenced by the detection in MW-202S (120 µg/L) and the downgradient OW-38 (deep overburden; 37 µg/L). While carbon tetrachloride did not have a site PRG developed previously, these concentrations are above the federal Maximum Contaminant Level (MCL) of 5 µg/L. There is also some residual evidence (1,1,1-TCA and 1,4-dioxane) in MW-203D of a historical release in the area.
- \$ Monitoring around the Locomotive Shop Disposal Areas [MW-204, MW-205, and MW-206] only showed exceedances of site PRGs by manganese (PRG - 300 µg/L).
- \$ Near the Asbestos Lagoons [MW-208, MW-209, OW-09/10/12, and OW-20], arsenic and manganese concentrations are still above site PRGs (10 µg/L and 300 µg/L, respectively). Most of the chlorinated VOCs detected historically have decreased in magnitude. One location, OW-20, showed increased detections of chlorinated VOCs.
- \$ The furthest downgradient wells [MW-1/1A/1B/1C] did not show any PRG exceedances and only showed low organic detections.
- \$ At the B&M Railroad Landfill [MW-213, MW-214, and MW-215; PZ-115], a LNAPL

sample was collected at PZ-115 and determined to be No. 6 Fuel Oil (see Appendix F for results). MW-214S (downgradient of PZ-115) showed PAH detections close to reporting limits. TCE was still detected in the bedrock wells MW-213B and OW-49 at concentrations above the PRG, but trending downwards. Arsenic and manganese were detected above site PRGs.

- \$ The wells sampled to provide information on the Contaminated Soils Area [MW-304 and OW-35] showed a few detections of organics close to reporting limits, and only manganese at OW-35 just above the site PRG. The wells which are on the upgradient end of the area (OW-37 and OW-38), may have been impacted by releases near the Old B&M Oil/Sludge Recycling Area, as well as site operations. These two wells have miscellaneous organics detected and, along with the carbon tetrachloride discussed above, show PCE detected above the site PRG in the deep overburden (OW-38).
- \$ For the RSI Landfill [MW-210, MW-211, MW-212, and OW-01/02], organic detections appear to be reducing in magnitude. Arsenic and manganese concentrations are still above site PRGs.
- \$ The Asbestos Landfill [MW-207, MW-305, MW-307, MW-308, OW-25/26, and OW-07/08] had seven new wells installed during this investigation. Upgradient locations showed a number of organics detected, including TCE and PCE above site PRGs in MW-207B. MW-306S showed detections close to the reporting limits of many SVOCs, including phenols, phthalates, and PAHs. These are likely residuals from the previous lagoon operations in the area. Downgradient locations (MW-307 cluster, MW-308B, OW-07 and -08) showed VOCs detected both above and below site PRGs. Benzene detections above the site PRG were confirmed in the area. Detections of chlorinated VOCs above site PRGs were also found in both the MW-307 cluster and MW-308B. As with the other areas of the site, arsenic and manganese concentrations were detected above site PRGs.

Following development of a Supplemental Human Health Risk Assessment (M&E, 2008a), further evaluation of contaminant distribution and trends was performed in a Supplemental Groundwater Data Evaluation Report (M&E, 2008b) related to updated Contaminants of Concern (COCs) and PRGs. Information from both of these reports is presented in Section 2 of this report.

1.4.3 Contaminant Fate and Transport

Similar to the historical discussion of contaminant nature and extent, the following sections present a description of contaminant fate and transport by AOC, as discussed in the OU-3 RI/FS (M&E, 1997; M&E, 2004). Discussion of surface and subsurface soil is included as it relates to groundwater contaminant fate and transport in each area. It should be noted that at the time of this report development, remedial designs are being generated to cover multiple AOCs at the site. Construction of these remedies is expected to impact the fate and transport of contaminants at the site.

1.4.3.1 B&M Railroad Landfill. Since organic materials are prevalent in soils, PCBs, PAHs, and pesticides are not expected to migrate appreciably in the unsaturated zone. It is also expected that the mobility of metals will be limited due to adsorption and other processes in soil. A migration pathway for VOCs in the unsaturated zone may be via vapor phase, since VOCs were detected more often at the water table (in groundwater screening locations) than with depth below it.

With the exception of VOCs, most contaminants found in the saturated zone soils (pesticides, PCBs, PAHs, phthalates, and heavy metals) will not migrate significantly in the dissolved phase as evidenced by the groundwater quality in wells across from B&M Pond. The presence of PCBs and pesticides below the limits of the waste indicate that residual or pooled dense non-aqueous phase liquids (DNAPL) may be present, although none was observed. Groundwater levels and

analytical data indicate that groundwater is migrating vertically. Contaminants in the dissolved phase may migrate from the landfill to the B&M Pond to the east and the Middlesex Canal to the south as evidenced by downgradient contamination. Measured vertical gradients indicate groundwater discharges to the Middlesex Canal and B&M Pond.

1.4.3.2 RSI Landfill. Borings indicate that wastes exist above and below the water table. The absence of a low-permeability cover allows for contaminant transport from the unsaturated to the saturated zone. Similar to the B&M Railroad landfill, relatively elevated concentrations of PCBs, PAHs, and phthalates are found in the unsaturated zone. These compounds in percolating water may be highly attenuated through adsorption to organic matter in the soils. Although these compounds may also migrate vertically in DNAPL form, no DNAPL was observed. Most metals are fairly immobile due to adsorption and low solubility; however, leaching is possible. Chlorinated VOCs (DCE and vinyl chloride) detected in groundwater screening samples indicate the partitioning of these compounds to the vapor phase. Therefore, vapor phase movement may be a prominent transport mechanism at the water table.

Most organic compounds with the exception of VOCs often do not migrate significantly in the dissolved phase. Pesticides, PAHs, phthalates, and PCBs adsorb to organic matter in soils. However, due to the presence of sandy soils with less organic material, contaminant transport is of greater concern. Based on the direction of groundwater flow, contaminants in the dissolved phase would likely migrate toward the Middlesex Canal to the northeast and the unnamed brook to the southeast. Although vertical gradients are low, the existence of shallow bedrock facilitates contaminant transport from the overburden to bedrock. The presence of pesticides and PCBs in the deep overburden and bedrock groundwater indicates the potential for localized DNAPL pools; however, this was not confirmed during the field activities. Measured vertical gradients and seepage velocities indicate discharge from groundwater to the unnamed brook.

1.4.3.3 B&M Locomotive Shop Disposal Areas. Borings indicate that wastes exist above and below the water table. PAHs were found in the highest concentrations, especially in subsurface

soils, while pesticides, PCBs, VOCs, and petroleum hydrocarbons were found at lower concentrations. The absence of a low-permeability cover facilitates contaminant transport from the unsaturated to the saturated zone. However, pesticides, PCBs and PAHs in percolating water may be highly attenuated through adsorption to organic matter in the soils.

Aromatic VOCs, PAHs, and petroleum hydrocarbons were notably absent in groundwater, although they were prevalent in subsurface soils. The absence of PAHs may be attributed to adsorption to soils. The absence of aromatic VOCs and petroleum hydrocarbons may be due to the placement of well screens below the water table. The potential for biodegradation of chlorinated compounds is evidenced by the existence of the breakdown products DCE and vinyl chloride near the water table. Based on the direction of groundwater flow, contaminants in the dissolved phase from both areas will migrate toward the northeast with potential downgradient discharge to the unnamed brook. Although vertical hydraulic gradients tend to be downward, there is no evidence that vertical migration of contaminants has occurred at this point.

1.4.3.4 Old B&M Oil/Sludge Recycling Area. Subsurface soils exhibited the highest concentrations of contaminants including aromatic VOCs, PAHs, petroleum hydrocarbons, and metals. Although some of the area is covered with asphalt, the absence of a low-permeability cover may facilitate contaminant transport to the saturated zone (especially VOCs). However, PAHs, pesticides, and metals will tend to adsorb to the organic matter (peat) prevalent in soils in this area. Based on observations of free product in the area and the occurrence of PAHs and petroleum hydrocarbons, LNAPL in residual or mobile form may be widespread. It was not detected in wells most likely because they are screened as much as 1 foot or more below the water table. The presence of high concentrations of PAHs may also indicate the presence of DNAPL. Note that current pre-design efforts for the source control remedy in this area include investigating for further evidence of LNAPL.

Aromatic VOCs, PAHs, and petroleum hydrocarbons were notably absent in groundwater, although they were prevalent in subsurface soils. The absence of PAHs may be attributed to

adsorption to soils. The absence of aromatic VOCs and petroleum hydrocarbons may be due to the placement of well screens below the water table. The potential for biodegradation of chlorinated VOCs is evidenced by the existence of the breakdown products DCE and vinyl chloride in groundwater. Based on the direction of groundwater flow, contaminants in the dissolved phase will likely migrate toward the northeast. Vertical hydraulic gradients tend to be downward from shallow overburden and upward from bedrock to deep overburden. The presence of chlorinated VOCs in the deep overburden lends credence to this observation.

1.4.3.5 Contaminated Soils Area. Soil contamination is likely the result of surface discharge from various work-related activities and is probably limited to surface soils. Evidence of free product spills included visual observation of oil-soaked or stained soils. Elevated levels of lead were detected throughout the area. Since lead is relatively insoluble and strongly adsorbed, significant migration in the unsaturated zone is not expected.

1.4.3.6 Asbestos Lagoons. The limits of waste relative to the water table were not defined, since drilling was not conducted within the lagoons. The predominant types of compounds found in groundwater include pesticides and PAHs, which are likely to be strongly adsorbed to soils. Concentrations of several metals were elevated, with calcium levels most elevated. This was to be expected due to the plasterboard materials that were disposed here.

Several metals, a few chlorinated VOCs, and PAHs were most prevalent in the deep overburden and bedrock groundwater. PCBs were detected in a shallow well adjacent to catch basins. Past wastewater discharges, stormwater drain leakages, and mounding caused by rainfall likely induced vertical migration of contaminants beneath the area. Low concentrations of pesticides in groundwater may be the result of percolating rainwater. Chlorinated VOCs are likely the most mobile contaminants. Groundwater flow is divided, with flow to the northwest toward Middlesex Canal and to the northeast. Vertical gradients tend to be downward from shallow to deep overburden near the lagoons, but upward from bedrock to overburden at the downgradient wells.

1.4.3.7 Site-Wide Surface Water and Sediment. Throughout the site, groundwater discharges to surface water and contributes contaminants to surface water. Inflow to surface water also consists of surface water runoff via overland flow and direct rainfall. Data collected indicate that fewer organic compounds were detected in September 1993 than in June 1993, which may reflect conditions of decreased groundwater discharge and overland flow runoff in late summer and early fall. Adsorption to sediments is likely the primary attenuation mechanism for contaminants in surface water.

Primary transport pathways for sediments include overland flow runoff from the adjacent land mass, including the potential source areas, and resuspension in the flowing water bodies, especially the Middlesex Canal and the Unnamed Brook. Contaminants detected in sediment were not typically detected in site groundwater. Pesticides were frequently detected in sediment across the site. PCBs have been detected in the Middlesex Canal due to past discharges from the Johns-Mansville facility (currently on BNZ Materials property). The adsorption of contaminants is likely, since the sediments are high in organic carbon content. Since surface water velocities are not high within the site, scouring and resuspension of sediments is not a dominant transport mechanism, but becomes more important during storm events that result in periods of high flow.

1.5 SUMMARY OF BASELINE HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENTS

Summaries of the RI human health risks and ERA/WRIA ecological risks are presented in the following sections by media and area of concern. Since analytical samples were not collected in the Asbestos Landfill, human health and ecological risks were not evaluated for that area of concern. In addition, since analytical samples related to ecological risk were not collected in the Asbestos Lagoons, that area was not evaluated separately in the ecological risk assessment. A summary of the supplemental human health risk assessment for the Old B&M Oil/Sludge Recycling Area is also presented. This supplemental evaluation was conducted during the FS process (M&E, 2004) for soil at the Old B&M Oil/Sludge Recycling Area to more fully address

risks associated with elevated levels of subsurface contaminants. Additionally, results from the supplemental human health risk assessment performed for groundwater (M&E, 2008a) have been summarized.

1.5.1 RI Human Health Risk Assessment

This section provides a summary of the baseline HHRA as presented in the Remedial Investigation Final Report (M&E, 1997). The baseline HHRA provides estimates of risk, under both current use and hypothetical future use scenarios, to both the central tendency (CT) and the reasonably maximum exposed (RME) receptor. Note that cumulative effects were calculated for each receptor, so discussions include reference to the following media: upland surface soil, sediment, surface water, and groundwater. Risks/hazards associated with surface soil are being addressed as part of the OU-3 remedy.

Surface soil analytical results were evaluated for five areas of concern (AOCs): B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Areas, Old B&M Oil/Sludge Recycling Area, and Contaminated Soils Area. Surface water and sediment analytical results were evaluated for three AOCs: West Middlesex Canal Area, Central Wetlands Area, and East Middlesex Canal and Wetlands Area. Groundwater analytical results from three aquifers (shallow overburden, deep overburden, and bedrock) were evaluated in five AOCs: B&M Railroad Landfill, RSI Landfill, B&M Locomotive Shop Disposal Area, Old B&M Oil/Sludge Recycling Area, and Asbestos Lagoons (*i.e.*, a total of 15 groupings).

To evaluate current exposures, child/teenage (*i.e.*, 7 to 16 years old) trespassers and adult site workers were considered as receptor populations. Exposures of both site workers and trespassers to surface soil through incidental ingestion of and dermal contact with COPCs were evaluated. Since industrial operations at the site would result in little, if any, contact by site workers with sediment and surface water in the wetlands or water bodies at the site, exposures of workers to sediment and surface water were not evaluated. However, exposures of child/teenage trespassers

to sediment and surface water were evaluated. Since most of the water bodies are shallow, trespassers were assumed to wade, rather than swim. Exposure pathways associated with wading that were evaluated include incidental ingestion of and dermal contact with sediment and dermal contact with surface water. The ingestion of surface water was not assessed since the water is shallow, making it unlikely that a trespasser would ingest more than a negligible amount. Note that construction workers were evaluated in the 2006 Supplemental HHRA (Section 1.5.3).

Since water is currently supplied to the site from alternative sources, exposures to COPCs in groundwater were not assessed under current land-use conditions. However, under a future land-use scenario, it was assumed that area residents would use groundwater from the site for domestic use. Routes of exposure associated with residential groundwater use may include ingestion of drinking water, inhalation of chemicals that have volatilized from groundwater during use (*e.g.*, while showering), and dermal contact with groundwater during use (*e.g.*, while bathing). Drinking water ingestion exposures of residents were quantitatively evaluated. Potential exposures from other pathways, such as inhalation or dermal contact during bathing, were not quantitatively evaluated.

The following items summarize the pathways evaluated for each exposure scenario.

- Site adult worker scenario, current and future
Ingestion pathways: surface soil
Dermal contact pathways: surface soil
- Site child/teenage trespasser scenario, current and future
Ingestion pathways: surface soil, sediment
Dermal contact pathways: surface soil, sediment, surface water
- Residential scenario, future
Ingestion pathways: groundwater

Carcinogenic and noncarcinogenic risks were estimated using both the CT and RME exposure assumptions. The significance of the risk estimates are relative to guidelines set forth in EPA policy (*i.e.*, an incremental lifetime cancer risk [ILCR] above the target risk range of 10^{-6} to 10^{-4}

and a hazard index [HI] above 1). Risk estimates, as presented in the RI for the RME case, are summarized in Appendix B of the OU-3 FS (M&E, 2004) and presented below by AOC.

1.5.1.1 B&M Railroad Landfill. In the B&M Railroad Landfill, potential exposures to surface soil and groundwater were evaluated. Health risks from surface soil are expected to be below or within the EPA risk range of 10^{-6} to 10^{-4} for cancer risk and below a hazard index of 1 for noncancer risk. Health risks from potential future ingestion of groundwater exceed EPA risk guidelines. Groundwater contaminants contributing to risks above EPA risk guidelines, under central tendency and RME scenarios for one or more flow zones, were arsenic and manganese.

1.5.1.2 RSI Landfill. In this area, potential exposures to surface soil and groundwater were evaluated. Health risks from surface soil are expected to be below or within the EPA risk range of 10^{-6} to 10^{-4} for cancer risk and below a hazard index of 1 for noncancer risk. Health risks from potential future ingestion of groundwater exceed EPA risk guidelines. Groundwater constituents contributing to risks above EPA risk guidelines, under central tendency and RME scenarios for one or more flow zones, were arsenic, manganese, benzene, and thallium.

1.5.1.3 B&M Locomotive Shop Disposal Areas. In this area, potential exposures to surface soil and groundwater were evaluated. Health risks from surface soil are expected to be below or within the EPA risk range of 10^{-6} to 10^{-4} for cancer risk and below a hazard index of 1 for noncancer risk. Occupational exposures to lead in soil may result in excess blood lead levels in female workers. Health risks from potential future ingestion of groundwater exceed EPA risk guidelines. Groundwater constituents contributing to risks above EPA risk guidelines, under central tendency and RME scenarios for one or more flow zones, were arsenic and manganese.

1.5.1.4 Old B&M Oil/Sludge Recycling Area. In this area, potential exposures to surface soil and groundwater were evaluated. Health risks from surface soil are expected to be below or within the EPA risk range of 10^{-6} to 10^{-4} for cancer risk and below a hazard index of 1 for noncancer risk. Health risks from potential future ingestion of groundwater exceed EPA risk

guidelines. Groundwater constituents contributing to risks above EPA risk guidelines, under an RME scenario for one or more flow zones, were arsenic and manganese.

1.5.1.5 Contaminated Soils Area. In this area, potential exposures only to surface soil were evaluated. Health risks from surface soil are expected to be below or within the EPA risk range of 10^{-6} to 10^{-4} for cancer risk and below a hazard index of 1 for noncancer risk. Estimated occupational blood lead levels were, however, elevated for this area due to the metals hot spot.

1.5.1.6 Asbestos Lagoons. In this area, potential exposures only to groundwater were evaluated. Health risks from potential future ingestion of groundwater exceed the EPA risk range of 10^{-6} to 10^{-4} for cancer risk and a hazard index of 1 for noncancer risk. Groundwater constituents contributing to risks above EPA risk guidelines, under central tendency and RME scenarios for one or more flow zones, were arsenic, beryllium, and manganese.

1.5.1.7 Site-Wide Surface Water and Sediment. Human health risks associated with potential exposures to surface water and sediment are expected to be within or below EPA risk range of 10^{-6} to 10^{-4} for cancer risk and below a hazard index of 1 for noncancer risk.

1.5.2 2004 Supplemental Human Health Risk Assessment

This section provides a summary of the supplemental baseline HHRA as performed as part of the OU-3 FS process (M&E, 2004) for the Old B&M Oil/Sludge Recycling Area. The supplemental baseline human health risk assessment provides estimates of risk, under hypothetical future use scenarios, to both the CT and the RME receptor. Note that risks/hazards associated with soil in this area are being addressed as part of the OU-3 remedy.

Soil analytical results (surface and subsurface soil combined) were evaluated for the Old B&M Oil/Sludge Recycling Area since subsurface levels for some contaminants exceeded levels in surface soils. It is assumed that future site development results in the movement of soil

contaminants, currently at depth, to the surface.

To evaluate future exposures, child/teenage (i.e., 7 to 16 years old) trespassers, adult site workers, adult utility workers, and adult/young child residents were considered as receptor populations. Exposures of receptors to soil through incidental ingestion of and dermal contact with COPCs were evaluated.

Carcinogenic and noncarcinogenic risks were estimated using both the CT and RME exposure assumptions. The significance of the risk estimates are relative to guidelines set forth in EPA policy (i.e., an incremental lifetime cancer risk [ILCR] above the target risk range of 10^{-6} to 10^{-4} and a hazard index [HI] above 1). Health risks from soil are expected to be below or within the EPA risk range of 10^{-6} to 10^{-4} for cancer risk and below a hazard index of 1 for noncancer risk. Estimated occupational blood lead levels were, however, elevated for this area due to the presence of metals in the subsurface. For the young child resident, soil lead concentrations were also associated with a blood lead level in excess of the blood lead level goal. Therefore, under future commercial or residential site uses, lead would present a risk above regulatory limits.

1.5.3 2006 Supplemental Human Health Risk Assessment

A supplemental human health risk assessment was performed to evaluate the current and potential future human health risks and hazards associated with direct and indirect exposure to groundwater potentially impacted by the site, based on groundwater data collected in the winter of 2005/2006 (M&E, 2008a). Receptors evaluated include a current/future commercial worker, future construction worker, and future adult/young child resident. Future use of groundwater was determined to be associated with a cancer risk and noncancer hazard in excess of risk management criteria. Results of the risk assessment are discussed below.

Risks Under Current Conditions. Incremental lifetime cancer risks (ILCRs) and hazard indices (HIs) were estimated for current commercial workers exposed to indoor air following the

subsurface migration of volatile contaminants in overburden groundwater into an occupied building. Total receptor ILCRs and HIs were below an ILCR of 10^{-4} and a HI of 1.

Potential Risks Under Future Conditions. ILCRs and HIs were estimated for the following receptors and exposure points: (1) future commercial workers exposed to indoor air following the subsurface migration of volatile compounds in overburden groundwater into an occupied building; (2) a future construction workers exposed to overburden groundwater contaminants via ingestion and dermal contact; and (3) future resident exposed to overburden/bedrock groundwater contaminants during household use of groundwater and following the migration of volatile overburden groundwater contaminants into indoor air.

ILCRs and HIs estimated for the future construction worker were below an ILCR of 10^{-4} and a HI of 1. No COPCs were selected for the inhalation of volatile compounds in outdoor air following their release from overburden groundwater. Therefore, the outdoor air pathway was not quantitatively evaluated.

ILCRs and HIs estimated for the future commercial worker and the future resident for the vapor intrusion pathway were below an ILCR of 10^{-4} and a HI of 1.

Under the assumption that on-site groundwater is used as a source of household water in the future, the RME ILCR and HI for future potable water use were estimated to exceed an ILCR of 10^{-4} and a HI of 1 due to the presence of: 1,2-dichloroethane, 1,4-dichlorobenzene, benzene, carbon tetrachloride, cis-1,3-dichloropropene, tetrachloroethene, trichloroethene, vinyl chloride, atrazine, bis(2-chloroethyl)ether, dibenz(a,h)anthracene, dieldrin, arsenic, cadmium, and manganese. These compounds were identified based on their association with an ILCR of greater than 10^{-6} and/or a target organ hazard quotient (HQ) greater than 1.

Because the future use of groundwater is associated with a cancer risk and noncancer hazard in excess of risk management criteria (target organ HI greater than 1; ILCR of greater than 10^{-4}),

identification of compounds present in excess of ARARs has been conducted. The following compounds exceed ARARs and require further evaluation in the feasibility study in addition to those identified as significant risk contributors in the supplemental risk assessment:

1,2-dichloroethane, benzene, carbon tetrachloride, tetrachloroethene, trichloroethene, arsenic, cadmium, and lead. Note that, with the exception of lead, these compounds were identified as significant risk contributing chemicals in the risk assessment. Due to a lack of toxicity values, lead was not quantitatively evaluated in the risk assessment, but identified as exceeding the drinking water lead criterion protective of childhood exposures. Iron was not quantitatively evaluated in the risk assessment because it is an essential nutrient and was eliminated prior to the contaminant of potential concern (COPC) selection process.

1.5.4 1997 OU-3 BERA

The 1997 BERA for OU-3 included an evaluation of the potential adverse effects of site COPCs to receptor populations in both terrestrial and aquatic habitats. Seven terrestrial habitat areas were described in Section 1.2 (the B&M Railroad Landfill, B&M Locomotive Shop Disposal Areas, the RSI Landfill, the Old B&M Oil/Sludge Recycling Area, the Contaminated Soils Area, the Asbestos Landfill, and the Asbestos Lagoons). Aquatic habitats were separated into the West Middlesex Canal Group, Wetland 2 Group, including Unnamed Brook, East Middlesex Canal Group, Richardson Pond Group, and Content Brook Wetland Group as shown on Figure 1-2. The sections below summarize the selection of COPCs, receptors and exposure pathways, and risk conclusions by area of the 1997 OU-3 BERA. The results of a benthic macroinvertebrate community assessment conducted as part of the 1997 OU-3 BERA are also presented.

1.5.4.1 Contaminants of Potential Concern. The data utilized in the 1997 OU-3 BERA were collected between June and September 1993. Seventy-seven shallow soil samples (0 to 12 inches) were collected from the seven terrestrial areas and used to evaluate risk to terrestrial receptors at these areas. For two of these terrestrial areas (Old B&M Oil/Sludge Recycling Area and the Contaminated Soils Area), the soil samples were analyzed, but data were not quantitatively

evaluated for potential effects to terrestrial receptors since these two areas were determined to have limited terrestrial habitat.

Forty-six sediment samples (0 to 6 inches deep) were used in selecting sediment COPCs. Surface water samples were also collected from all 46 sediment locations in June 1993. During September 1993 a second round of surface water samples was performed at the majority of the locations, with a few excluded due to low water levels.

Surface water, sediment, and soil analytical data were summarized by medium and grouped by area. Contaminant concentrations in each medium were screened against medium-specific benchmarks. In addition, if chemicals in each medium were detected site-wide in 5% or fewer of the samples, then these compounds were eliminated from further evaluation. Maximum detected concentrations of metals were also compared to medium-specific background concentrations. Those metals detected at concentrations less than background levels were eliminated as COPCs, however, in selection of COPCs carried forward to the ERA/WRIA, those COPCs eliminated solely based on background were re-assessed.

The B&M Railroad Landfill and the Contaminated Soils Area contained numerous PAHs and pesticides at elevated concentrations. The B&M Railroad Landfill had the largest number of COPCs (33), with 16 of these being PAH compounds.

The COPCs identified in sediment were primarily PAHs, pesticides, and metals. Many of the metals (*e.g.*, aluminum, barium, iron, manganese, and vanadium) were detected in the majority of sediment samples and were selected as COPCs. Those sediment groups that contained more ponded (standing water) sampling areas (Wetland 2 Group, Richardson Pond Group, and Content Brook Wetland Group) had the greatest number of COPCs. The two areas characterized primarily as more stream-like (flowing water), West Middlesex Canal Group and East Middlesex Canal Group, contained the fewest sediment COPCs. The location and magnitude of the concentrations of COPCs in sediment observed in the 1993 data compared to the 2004 data were

discussed in Section 2.2.3 of the ERA/WRIA (M&E, 2006a).

Analysis and COPC selection for surface water were based on total concentrations of metals, because dissolved metals analysis for surface water was not routinely done at the time of the 1993 data collection. Similar to the results of the sediment COPC screening, a larger number of COPCs were identified in the ponded habitats (Wetland 2 Group, which includes B&M Pond, Richardson Pond Group and Content Brook Wetland Group), as opposed to the stream habitats (East and West Middlesex Canal Groups). The COPCs selected for surface water were primarily metals.

1.5.4.2 Summary of Receptors and Pathways. Table 1-6 summarizes the assessment and measurement endpoints selected for the 1997 OU-3 BERA. Potential exposure pathways were identified for terrestrial and aquatic receptors. For surface soils, terrestrial invertebrates (earthworms) and small mammals (short-tailed shrew) were selected as representative receptor species. The potential effect of soil contaminants was evaluated by a comparison of average COPC concentrations to screening benchmarks.

The potential effect of site-related contaminants on aquatic receptors was evaluated in the 1997 OU-3 BERA through comparisons of surface water and sediment COPC concentrations to surface water and sediment benchmarks. The potential effect of site-related contaminants on a predatory bird population was evaluated through a food-chain model for the great blue heron. The model estimated the potential dose to great blue heron from ingesting fish based on modeling fish tissue COPC concentrations from surface water and sediment. The heron diet was assumed to be composed primarily of fish, with a minor contribution from benthic invertebrates. In addition, a qualitative survey of benthic invertebrates was conducted to evaluate the composition of the invertebrate community in comparison with reference locations.

1.5.4.3 Summary of Risk by Area. Adverse effects to soil invertebrates and short-tailed shrews from dietary exposures of SVOCs, pesticides, and metals from the ingestion of earthworms,

surface soil, and surface water at the B&M Railroad Landfill, RSI Landfill, and B&M Locomotive Shop Disposal Areas (A and B) were evaluated. The results of the earthworm and short-tailed shrew analyses indicated the potential for reductions in both soil invertebrate and small mammal populations at the B&M Railroad Landfill and B&M Locomotive Shop Disposal Areas (A and B).

In general, metals and SVOCs (mostly PAHs) are the two contaminant groups of concern. The proposed remedies (source control via capping and/or excavation) for these areas are expected to eliminate the exposure pathways for terrestrial receptors.

The evaluation of ecological risk in aquatic habitats identified minimal risks from surface water in the Middlesex Canal. The results of the evaluation of potential risks to benthic receptors due to exposure to sediment COPCs in the Middlesex Canal indicate potential risks from exposure to SVOCs and also from exposure to copper, lead, PCBs, and 4,4'-DDD on a limited spatial scale.

The BERA evaluation also indicated the potential for adverse effects on aquatic populations as a result of the observed concentrations of metals in surface water in the Wetland 2 Group (barium, iron, and lead), Richardson Pond Group (barium, iron, and lead), and Content Brook Wetland Group (aluminum, arsenic, barium, iron, manganese, and silver). In addition, maximum surface water concentrations indicated potential risk from exposure to chromium, cobalt, copper, and vanadium in surface water site-wide. Results of the sediment analysis for benthic receptors indicated potential adverse effects on benthic invertebrate communities could occur as a result of the observed concentrations of PAHs and metals in sediments in the Wetland 2 Group, Richardson Pond Group, and Content Brook Wetland Group.

A potential for adverse effects on piscivorous bird populations from fish COPC ingestion, modeled from sediment data, was identified in the Wetland 2 Group, Richardson Pond Group, and the Content Brook Wetland Group from exposures to metals and SVOCs (particularly dibenz(a,h)anthracene).

1.5.4.4 Benthic Macroinvertebrate Community Analysis. As part of the 1997 OU-3 BERA

data collection, macroinvertebrate samples were collected at sampling locations (see Figure 1-4) in on-site and reference areas following procedures identified in Plafkin *et al.* (1989). Of the 24 benthic invertebrate sampling locations, five (RS-01, RS-02, MC-01, RW-01, and RP-04) were located away from known sources of on-site contamination and were considered reference locations. In general, the macroinvertebrates were sorted and identified taxonomically to family-level. If greater than 50 individuals of a taxon were enumerated, the count was reported as greater than 50. The habitat quality of each sampling location was also evaluated by qualitatively assessing the following five habitat parameters: bottom scouring and deposition; pool/riffle, run/bend ratio; bank stability; bank vegetative stability; and streamside cover.

Two types of aquatic habitats were observed among the sampling locations in which benthic macroinvertebrates were sampled. Lentic habitats were generally characterized by no flow and were located within a pond or unchannelized wetland. Lotic habitats were generally characterized by some flow, at least seasonally, and were located in a channelized area of a stream or wetland.

The presence of ephemeroptera, plecoptera, and trichoptera (EPT) were also characterized for the sampling locations. The absence of pollution-sensitive benthic invertebrates such as the EPT taxa is often an indicator of some impairment in the stream habitat. The only EPT taxa that were present in any on-site surface water/sediment group were trichoptera. However, this is likely the result of the low gradient and depositional habitats at most sampling locations, and, as a result, indices based on EPT taxa did not provide much information on water quality among the benthic reconnaissance locations.

In the West Middlesex Canal Group (MC-02, MC-03, MC-04), the macroinvertebrate communities seemed to be generally similar to the lotic reference locations. No amphipoda were collected at MC-02, but this is probably related to low concentrations of dissolved oxygen (DO), as MC-02 had one of the lowest DO concentrations measured at any sampling location.

In the Wetland 2 Group, the macroinvertebrate community at UB-02 was similar to that at the lentic reference locations. The macroinvertebrate communities at sampling locations UB-01 and

UB-03 were similar to that of the lotic reference locations. Sampling location UB-04 had fewer Amphipoda, but 17% of the organisms collected were EPT taxa, specifically trichoptera, of which four of five individuals were hydropsychidae or net-spinning caddisflies that require some current. This difference is likely related to the moderate current and more sandy, less organic sediments at UB-04.

In the Richardson Pond Group, RP-01 differed from the lotic reference locations in that fewer individuals and fewer amphipoda were collected. However, this sampling location had no flow and the DO concentration was low. Sampling location RP-03 was similar to the lentic reference locations, but fewer invertebrate taxa, fewer individuals, and no mollusca were collected at RP-02. However, RP-02 had the lowest measured DO concentration of any sampling location.

In the East Middlesex Canal Group, sampling location MC-05 was relatively similar in benthic composition to the lotic reference locations. Few taxa were collected at MC-09, but several hydropsychidae were collected (10% EPT organisms). As with UB-04, this difference was related to the moderate current and lower organic carbon content of sediments that characterized MC-09. Sampling location MC-10 was similar to the lotic reference locations in the number of taxa and individuals collected, but differed in that diptera were the dominant taxa, instead of amphipoda. However, many of these diptera were in the family ptychopteridae, which is characteristic of highly organic sediments, such as those described for MC-10, and does not necessarily indicate adverse effects from exposure to sediment contaminants.

In the Content Brook Wetland Group, MC-06, MC-07, and MC-08 were all similar in benthic composition to the lotic reference locations, and CB-03 was similar in benthic composition to the lentic reference locations. Sampling location CB-01 differed from the lotic reference locations in that fewer taxa, individuals, mollusca, and amphipoda were collected. There was no flow at CB-01, but no surface water data were available for this sampling location to determine the possible influence of DO. Sampling location CB-02 differed from the lentic reference locations in that fewer taxa, individuals, and no mollusca were collected, but the number of damselflies (*i.e.*,

anisoptera) collected was the most of any site, except CB-03. This difference may be related to the relatively low DO concentration that was measured and to habitat characteristics.

In general, qualitative evaluation of the macroinvertebrate survey data did not find any overt adverse effects that appeared to be related to site contaminants. Most of the effects appeared to be related to differences in DO concentrations, flow, and sediment characteristics. However, more subtle effects may not have been detectable because of the lack of replication and quantitative evaluation of data, the low number of individuals collected at most sampling locations, and dissimilarities in physical characteristics among the reference and site-associated sampling locations.

Subsequent to the 1997 OU-3 BERA, a quantitative evaluation of the benthic macroinvertebrate data was conducted in early 2004 in order to reduce the uncertainty concerning the conclusion of no overt effect due to site contaminants. A multivariate analysis of the benthic invertebrate data was conducted in conjunction with an analysis of: (1) environmental variables measured during the survey; and (2) sediment benchmark hazard indices of contaminant levels in sediment at the sampling stations. The hazard index of the sediments was calculated as the mean Probable Effect Concentration (PEC) quotient.

A summary of the multivariate analysis is presented in Appendix B of the ERA/WRIA (M&E, 2006a). The multivariate ordination used to analyze the 1997 OU-3 BERA macroinvertebrate data for differences in community structure was a correspondence analysis (CA).

A biplot ordination of the invertebrate site scores indicated that the reference sites were not different as a group from the other sites. A comparison of the distribution of the site-scores for axes 1-4 of the CA ordination was done with box plots, along with a comparison of the eigenvalues for each axis. Based on an evaluation of these results, there were no discernible effects that indicated that community structure was different between reference sites as one group and on-site locations as a second group.

The community site scores derived from the CA ordination were regressed against the environmental variables recorded at the sites. The variables that represented contamination and toxicity at the sites showed very weak correlations with community structure. The highest correlation coefficient of the community composition data was with habitat characteristics (bend ratio) from which the sample was collected. This result is not unexpected, because the bend ratio may represent sinuosity of a water body, which is important in creating habitat features in an aquatic environment. Consequently, additional habitat features increase the heterogeneity of an aquatic environment, and in turn will contribute to supporting different taxa, which increase the community structure. These characteristics of the habitat showed more influence over the community composition than did any response to measured toxicity gradients.

The CA analysis supported the earlier conclusions of the qualitative analysis of the macroinvertebrate data. There were no discernible patterns that indicated that community structure was different between reference and on-site benthic communities. In addition, the analysis did not detect any strong community response that appeared to be related to site contaminants. The inability of the evaluation to detect responses to contaminants may be attributed to sampling method, the insufficient level of taxonomic identification, and the characteristic noise in benthic community data, which may overwhelm the more subtle, but potentially important, responses to chemical gradients. This result does not imply that the benthic community is unaffected by contaminant distribution, only that the data collected were not detailed enough to allow these patterns to be seen within the variation of response of the community composition to other environmental variables.

1.5.5 Summary of ERA/WRIA

The ERA/WRIA was prepared as an addendum to the BERA conducted for OU-3 (M&E, 1997). Receptors, wetland areas, and contaminants which were not found to pose ecological risk in the BERA were not carried forward to the ERA/WRIA. Risks identified in the 1997 OU-3 BERA

were further evaluated based on additional data collected in 2004.

Specifically, the ERA/WRIA was designed to address potential risks to the environment including risks to aquatic receptors exposed to target metals in surface water, risks to benthic invertebrates directly exposed to 4,4'-DDD, PCBs, PAHs, and target metals in sediment within the on-site wetlands and ponds, and risks to predatory birds (*e.g.*, heron) indirectly exposed to PAHs and target metals in biota within on-site habitats that support fish for their diet, as identified in the 1997 OU-3 BERA. Target metals are identified as those metals potentially contributing to risk as determined in the OU-3 BERA and include: aluminum, arsenic, barium, silver, chromium, cobalt, copper, iron, manganese, lead, vanadium, and zinc.

Supplemental sampling in 2004 included additional chemical analysis of surface water and sediment, toxicity testing in surface water and sediment, and fish tissue sampling. Surface water samples were collected from one reference area (Round Pond) and four surface water areas on-site including the Middlesex Canal, Richardson Pond, B&M Pond, and Content Brook. These samples were used to evaluate toxicity to aquatic receptors from exposure to target metals in surface water. Surface water samples were analyzed for toxicity, as well as in triplicate for total and dissolved metals and alkalinity. Surface water toxicity tests were conducted on daphnid (*Ceriodaphnia dubia*) and minnow (*Pimephales promelas*).

Fish tissue samples were also collected at these five open water locations (four on-site and one reference) to model dietary exposure of heron based on site-specific fish tissue concentrations of PAHs and target metals.

Sediment samples were collected to further evaluate toxicity to benthic invertebrates from exposure to 4,4'-DDD, PCBs, PAHs, and target metals in sediment within the on-site wetlands and ponds. Sediment samples were collected in a phased approach. Based on historic data and site reconnaissance, twenty on-site sampling locations and three reference locations were selected for field screening for target metals, PAHs, PCBs, and Microtox[®] toxicity. Based on the field-

screening results, a subset of four on-site sediment sampling locations was selected to represent the sediments with highest potential toxicity. The least toxic/contaminated location among the three potential reference locations was selected for analysis as the representative reference location. These five sediment samples, including four non-reference and one reference location, were evaluated using laboratory sediment toxicity testing and analytical methods. These data, in conjunction with historic data and field-screening results, were used to evaluate the potential toxicity of site-related contaminants on benthic organisms.

The ERA/WRIA data demonstrate that similar patterns of contaminants in sediment and surface water were found in 2004 and 1993. The ERA/WRIA based conclusions of risk on the evaluation of the combined data set from 1993 and 2004, the 2004 toxicity data, along with the supporting patterns of the Microtox[®] data, and the previous evaluations of the 1997 BERA.

Based on the analysis of surface water data and surface water toxicity testing, the risk to aquatic invertebrates from exposure to metals in surface water is negligible. Since the study was designed to evaluate exposure scenarios representing the highest contaminant concentrations on-site, and for surface water these concentrations did not exceed levels associated with toxicity or ecological effects, the conclusion can be made that there is no unacceptable ecological effects to the selected receptor from exposure to surface water at any of the site areas.

Based on the concentrations of contaminants detected in fish tissue compared to residue effect levels, the risk to fish from exposure to COPCs at the site is negligible. In the majority of the water bodies on-site, the risk from exposure to COPCs in surface water is also negligible. There is low risk to minnows in West Middlesex Canal, based on uncertain results from one surface water toxicity test and no toxicity to minnows and daphnids at all other AOCs (see Table 1-2). Based on the lack of supporting data from other lines of evidence, and lack of the association of this risk to surface water COPCs measured, the risk to minnows is not considered significant.

The dietary modeling results for the great blue heron indicate that the concentrations of COPCs in

fish collected on-site are below levels expected to cause ecological effects. The risk to piscivorous birds feeding at the site is negligible. Since the exposure scenarios representing the maximum contaminant concentrations on-site did not exceed levels associated with adverse effects for great blue heron dietary models, the conclusion can be made that there are no unacceptable ecological effects to great blue heron populations feeding in the site area.

The risks to benthic invertebrates exposed to sediment contaminants of concern are negligible (no evidence of risk) at Content Brook, low in West Middlesex Canal, and moderate in B&M Pond and the Unnamed Brook (see Table 1-7). The areal distribution of COPCs contributing to risk demonstrate a spatial pattern of highest concentrations in the upstream and central portions of the site (Unnamed Brook and B&M Pond wetland). Total PAHs, chromium, copper, lead, and zinc have the highest concentration in the upstream and central portions of the site and diminish in concentration downgradient in the Middlesex Canal and in Content Brook. In addition, the highest observed effects in the sediment toxicity test and Microtox® analysis shows a pattern consistent with the contaminant distribution.

This spatial pattern of contaminant concentration and associated sediment toxicity supports an interpretation that the site-related COPCs are likely to have been transported short distances downstream, as sediment-bound particles, and settled or re-deposited in depositional environments along the Unnamed Brook or in areas of B&M Pond. The significance of the spatial distribution of PAHs and metals on-site is that it indicates these major COPCs have migrated downstream to B&M Pond, but have not migrated further downgradient to Content Brook or off-site.

Based on the analysis of the three selected indicators/endpoints, there are no indications of unacceptable ecological risk to aquatic receptors or predatory birds on-site. Evidence suggests that there is high exposure to organic and metal contaminants of concern for benthic invertebrates on the site. Risks from the exposure to sediments are highest in the Unnamed Brook and B&M Pond. Based on the evaluation of benthic invertebrate data, there are unacceptable ecological

risks to benthic invertebrates in the Unnamed Brook and B&M Pond, with uncertain risk in Richardson Pond at SD-111. Based on the low sediment toxicity, and low magnitude and frequency of sediment benchmark exceedances in West Middlesex Canal and Content Brook, the risks to benthic invertebrates are low or negligible in these areas, and do not represent an unacceptable risk.

SECTION 2.0

DEVELOPMENT OF REMEDIATION CRITERIA AND SCREENING OF TECHNOLOGIES

Based on the results of the RI, supplemental investigations, and risk assessments conducted for the site, contaminants identified at the site pose risk to ecological and human receptors and require remediation. In order to best select remediation approaches, criteria are developed based on applicable regulatory requirements and risk-based concentrations of contaminants present at the site. The remediation criteria are presented as Remedial Action Objectives (RAOs), supported by numeric cleanup goals called Preliminary Remediation Goals (PRGs) and regulatory requirements (Applicable or Relevant and Appropriate Requirements [ARARs]). Section 2.1 identifies chemical-, location-, and action-specific ARARs. Section 2.2 provides the basis for and selection of RAOs and site-specific PRGs for each area and medium of concern.

2.1 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

ARARs consist of federal and state human health and environmental requirements and guidelines that may affect implementation of remedial alternatives. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the 1986 Superfund Amendments and Reauthorization Act (SARA), 42 U.S.C. ' 6901 *et seq.*, and the National Contingency Plan (NCP), 40 C.F.R. Part 300, require identification of all potential ARARs that must be addressed by the EPA or parties undertaking the remedial action. Determination of ARARs is site-specific and depends on the chemical contaminants, site/location characteristics, and remedial actions being investigated for site cleanup.

CERCLA governs the liability, cleanup, financial responsibility, and response for hazardous substances released into the environment. CERCLA requires that all remedial actions be consistent with the NCP. The NCP specifies procedures, techniques, materials, equipment, and methods to be employed in identifying, removing, or remediating releases of hazardous

substances. In particular, the NCP specifies procedures for determining the appropriate type and extent of remedial action at a site in order to effectively mitigate and minimize damage to, and provide adequate protection of, human health, welfare, and the environment.

The national goal of remedy selection is to protect human health and the environment, to maintain that protection over time, and to minimize untreated waste (40 CFR Part 300.430 of the NCP (55 FR 8846)). In accordance with Section 121(d) of CERCLA, 42 U.S.C. ' 9621, site remediation must comply with all applicable or relevant and appropriate laws, regulations, and standards promulgated by the federal government, except where waived. Substantive State environmental and facility siting requirements must also be attained, under Section 121(d)(2)(c) of CERCLA, 42 U.S.C. ' 9621, if they are legally enforceable and consistently enforced statewide, and if the state ARAR is more stringent than the federal ARAR and has been presented to the EPA in a timely manner. Waiver conditions that may be used, if protection of human health and the environment is to be ensured, include the following:

- \$ The remedial action selected is only part of a total remedial action that will attain such level or standard of control when completed
- \$ Compliance with such requirements is technically impracticable from an engineering perspective
- \$ Compliance with such requirement at that facility will result in greater risk to human health and the environment than alternative options
- \$ The remedial action selected will attain, through use of another method or approach, a standard of performance that is equivalent to that required under the otherwise applicable standard, requirement, criteria, or limitation
- \$ In the case of a remedial action to be undertaken solely under Section 104 of CERCLA, 42 U.S.C. ' 9604, selection of a remedial action that attains such level or standard of control will not provide a balance between the need for protection of public health and welfare and the environment at the facility under consideration, and the availability of money from the fund to respond to other sites, taking into consideration the relative immediacy of such threats

§ With respect to a state standard, requirement, criteria, or limitation, the state has not consistently applied (or demonstrated the intention to consistently apply) the standard, requirement, criteria, or limitation in similar circumstances at other remedial action sites within the state

Section 121(e) of CERCLA, 42 U.S.C. ' 9621, codified in the NCP at 40 CFR Part 300.400(e), exempts any response action conducted entirely at the site from having to obtain a federal, state, or local permit, where the action is carried out in compliance with Section 121. Remedial actions conducted on Superfund sites need comply only with the substantive aspects of ARARs and not with the corresponding administrative requirements.

2.1.1 Definition of ARARs

As defined by the NCP, ARARs are placed into three classifications: applicable requirements, relevant and appropriate requirements, and other requirements to be considered. Applicable requirements are promulgated statutory or regulatory cleanup standards and environmental protection criteria that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a site. Included are federal requirements that are directly applicable, as well as those incorporated by a federally authorized state program. State standards that are more stringent than federal requirements may be applicable. Relevant and appropriate requirements are promulgated statutory or regulatory cleanup standards and environmental protection criteria that while not directly "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a site, address similar situations or problems to those encountered. Other environmental and public health guidelines which may be considered to help determine remedial alternatives, but are not ARARs, are termed To Be Considered (TBC). A requirement may be either "applicable" or "relevant and appropriate," but not both. Three categories of ARARs are considered: chemical-specific, location-specific, and action-specific.

2.1.2 Chemical-Specific ARARs

Chemical-specific ARARs are numeric values that provide criteria for evaluating concentrations of specific hazardous contaminants and are developed based upon protection of human health and the environment. These values establish the acceptable amount or concentration of a chemical that may be found in or discharged to the environment. The potential chemical-specific ARARs and TBCs that apply to site groundwater and sediment are described in Table 2-1 and provide a basis for the numerical values provided in development of site PRGs in Appendix A.

2.1.3 Location-Specific ARARs

Location-specific ARARs serve to protect individual characteristics, resources, and specific environmental features on a site, such as wetlands, water bodies, floodplains, and sensitive ecosystems. Location-specific ARARs may affect or restrict remediation and site activities. The location-specific ARARs that apply to site groundwater and sediment are listed in Table 2-2. The applicability of the location-specific ARARs to each remedial alternative will be discussed during detailed evaluation of alternatives (Section 5.0).

2.1.4 Action-Specific ARARs

Action-specific ARARs are technology- or activity-based requirements of activities or processes that may be implemented on a site, including storage, transportation, and disposal methods of hazardous substances as well as construction of facilities or treatment processes. The action-specific ARARs and TBCs that apply to site groundwater and sediment are listed in Table 2-3. As action-specific ARARs and TBCs are defined by the components of a potential remedy, they will be discussed for each remedial alternative during detailed evaluation of alternatives (Section 5.0).

2.2 DEVELOPMENT OF RAOs AND PRGs

RAOs consist of medium-specific goals for protecting human health and the environment, and provide a basis for remedial alternative development and evaluation during the FS process. The RAOs specify the contaminants of concern, exposure routes and receptors, and numeric PRGs for each exposure scenario within each medium/area of concern. The RAOs permit the development of a range of alternatives that may achieve protection by reducing exposure to and/or reducing concentrations of contaminants within each medium/area of concern. For the purposes of the FS, RAOs were developed for each medium to allow for flexibility in decisions regarding the implementation of remedial actions.

2.2.1 Basis of RAOs

2.2.1.1 Groundwater. RAOs for groundwater were developed based on the results of the supplemental HHRA conducted for groundwater (M&E, 2008a). ARARs (e.g., federal Maximum Contaminant Levels [MCLs]), background considerations, and analytical practical quantitation limits (PQLs) were also utilized in developing RAOs.

EPA guidelines for baseline risks and hazards at a Superfund site are generally that noncarcinogenic hazard for each target organ should not exceed a total HI of one, and the total receptor ILCR should not exceed the target risk range of 10^{-6} to 10^{-4} . RAOs are limited to media, geographic areas, and chemicals for which estimated risks and hazards exceed EPA's risk management criteria. As noted in Section 1.5.3, exposure to site-wide groundwater (overburden and bedrock combined) by future potential residents results in an exceedance of EPA's risk criteria. Therefore, RAOs and PRGs are necessary for site-wide groundwater.

RAOs for groundwater are summarized in Table 2-4. The human health RAOs for site-wide groundwater include specific objectives to reduce risks and hazards identified in the supplemental

HHRA as above EPA's risk management criteria. With most of the groundwater under the site designated as a non-potential drinking water source area (see Section 1.3), as well as lack of a well-defined contaminant plume, a compliance zone boundary has been designated for the site (see Figure 2-1). While one groundwater RAO has been developed to prevent exposures to contaminated groundwater by future residential users, another RAO has been developed to prevent migration of contaminated groundwater beyond the compliance boundary to limit potential off-site exposures to residences with private wells.

RAOs were developed under the assumption that scheduling of remedial actions (source control) associated with OU-3 will be performed in such a manner that recontamination of groundwater resulting from future contaminant migration to groundwater will be limited.

2.2.1.2 Sediment. RAOs for sediment were developed based on the results of the ERA/WRIA conducted for contaminated media specific to each area of concern (M&E, 2006a). As noted in Section 1.5.5, the media/areas of concern requiring RAOs include: (1) sediment in Unnamed Brook; and (2) sediment in B&M Pond.

The Unnamed Brook and associated wetlands are adjacent to an operating railyard and other commercial/industrial facilities. Results presented in the ERA/WRIA and summarized in Section 1.4.1 have determined that the system is performing as wetlands typically do. According to the data, the wetland complex appears to be acting as a sink for stabilizing and burying contaminants associated with sediments that may be transported to the wetland via resuspension and run-off within the Unnamed Brook. This process appears to have limited off-site migration of those contaminants that have become stable within the wetland of the Unnamed Brook and have not migrated further downstream. Therefore, while it appears that existing natural mechanisms will continue to reduce ecological exposures to sediment contaminants in Unnamed Brook, limiting site storm water runoff will be necessary to limit further recontamination of sediment and reduce the timeframe of recovery.

RAOs for sediment are summarized in Table 2-4. The ecological RAOs for the site include specific objectives to reduce risks identified in the ERA/WRIA as unacceptable. RAOs were developed under the assumption that scheduling of remedial actions (source control) associated with OU-3 and remedial actions associated with OU-4 groundwater will be performed in such a manner that recontamination of sediment resulting from future contaminant migration will be limited.

2.2.2 Development of PRGs

2.2.2.1 Groundwater. Groundwater PRGs (applicable to groundwater migrating beyond the compliance boundary) are developed based on an evaluation of risk-based PRGs, background concentrations, PQLs, and other site-specific considerations (e.g., ARARs) in order to select the PRG. If there are established ARARs for chemical-specific concentrations (e.g., federal or state MCLs), these are selected as PRGs. In the absence of established ARARs, risk-based PRGs are selected, developed using EPA guidance provided in *Development of Risk-based Preliminary Remediation Goals* (U.S. EPA, 1991), following the consideration of background concentrations and PQLs.

Risk-based PRGs are developed for site-wide groundwater associated with potential future cumulative cancer risks greater than 10^{-4} or target organ HIs greater than 1 considering the residential ingestion, dermal contact, and inhalation exposure pathways. For groundwater, risk-based PRGs are appropriate for each chemical with an individual cancer risk above 10^{-6} or with a hazard quotient (HQ) above 1. These chemicals are identified as chemicals of concern (COCs) and include 1,2-dichloroethane, 1,4-dichlorobenzene, benzene, carbon tetrachloride, cis-1,3-dichloropropene, tetrachloroethene, trichloroethene, vinyl chloride, atrazine, bis(2-chloroethyl)ether, dibenz(a,h)anthracene, dieldrin, arsenic, cadmium, and manganese.

The human health risk-based PRGs provided in Appendix A-1, Table 8, correspond to target cancer risk levels of 10^{-6} , 10^{-5} , and 10^{-4} and a target noncancer HQ of 1. A human health risk-

based PRG for a COC may be selected corresponding to any of the target risk/hazard levels identified, so long as the cumulative cancer risk and target organ non-cancer hazard for a receptor meet regulatory criteria (cumulative ILCR of 10^{-6} to 10^{-4} and target organ HI of 1).

For each of the COCs, risk-based PRGs were calculated using equations and exposure assumptions presented in Appendix A-1, Table 2. Toxicity values used in the calculation of the risk-based PRGs are presented in Appendix A-1, Tables 3 through 6. Additional equations and parameters applicable to organic compounds for the water dermal pathway are presented in Appendix A-1, Table 7. The human health risk-based PRGs for each COC are summarized in Appendix A-1, Table 8. The PRGs, selected by considering the ARARs, risk-based PRGs, PQLs, and background, are provided in Table 2-5.

PRGs for groundwater correspond to MCLs selected as ARARs for the site, except for cis-1,3-dichloropropene, bis(2-chloroethyl)ether, dibenz(a,h)anthracene, dieldrin, and manganese which lack established compound-specific ARARs. The groundwater PRG for cis-1,3-dichloropropene ($0.49 \mu\text{g/L}$) corresponds to an ILCR of 10^{-6} for future residential water usage. The PRGs for bis(2-chloroethyl)ether ($0.5 \mu\text{g/L}$), dibenz(a,h)anthracene ($0.1 \mu\text{g/L}$), and dieldrin ($0.01 \mu\text{g/L}$) are based on the practical quantification limit achievable by laboratories at this time. The groundwater PRG for manganese ($300 \mu\text{g/L}$) is based on the federally-established health advisory.

Limitations and uncertainty of predicting human health risks and hazards were discussed in the supplemental HHRA (M&E, 2008a). Much of the uncertainty in the supplemental HHRA also applies to the risk-based PRGs since PRG development is based on chemicals and exposure scenarios identified in the supplemental HHRA. Also, the PRGs were developed using the same exposure assumptions and parameters used in the supplemental HHRA. Dose-response uncertainty is common to all hazardous waste risk assessments. There are many uncertainties regarding the amount of contact there will be in the future between potential receptors and the groundwater contaminants of concern. A complete discussion of the HHRA uncertainties may be found in the supplemental HHRA (M&E, 2008a).

2.2.2.2 Sediment. Sediment PRGs are developed based on an evaluation of risk-based PRGs, background/reference concentrations, and other site-specific considerations (e.g., ARARs) in order to select the PRG. The approach used to develop the sediment PRGs involved using site-specific No Observed Effects Concentrations (NOECs) and Lowest Observed Effects Concentrations (LOECs) to establish a Maximum Acceptable Toxic Concentration (MATC) for each COC in sediment. The MATC is the geometric mean of the NOEC and LOEC (Appendix A-2). The MATC is therefore derived from site-specific data and adopted as the sediment PRG for each of the COCs corresponding to a low (acceptable) risk to aquatic life receptors, such as benthic macroinvertebrates. The sediment PRG refinement step is presented in Appendix A-2 with selected sediment PRGs listed in Table 2-6. As noted in Appendix A-2, the calculated MATC value for Total PCBs is significantly lower than PCB levels selected as sediment PRGs at other sites, such that its validity is questionable. Therefore, the USEPA has selected an average PCB concentration of 1 mg/kg as a sediment cleanup goal to be used for risk management associated with B&M Pond and Unnamed Brook. This sediment PRG is consistent with sediment cleanup goals selected at other PCB sites in New England.

2.3 MEDIA POTENTIALLY REQUIRING REMEDIATION

To develop alternatives, it is first necessary to determine areas or volumes of media to which general response actions might be applied. To ensure that alternatives can be assembled to reduce exposure(s) to protective levels, volume(s) or area(s) should be reviewed with respect to the RAOs. Media potentially requiring remediation include sediment and groundwater (west of Pond Street) which could potentially migrate off-site at concentrations greater than PRGs. Estimated extents of on-site contamination in groundwater and sediment are summarized in Table 2-7 and/or defined below. Groundwater PRG exceedances are presented as an indication of on-site contaminant nature and extent for use in considering potential off-site migration of contaminants.

Groundwater. Figures 2-2 (overburden) and Figure 2-3 (bedrock) present the on-site

groundwater sampling locations which had PRG exceedances in winter 2005/2006. These exceedances are summarized in Table 2-7. Further discussion of these exceedances, with respect to historical trends, is presented in the Supplemental Groundwater Data Evaluation Report (M&E, 2008b) and summarized below.

For the Supplemental Groundwater Data Evaluation Report, the sampling results were evaluated based on AOC and flow zone (overburden or bedrock). Table 2-8 presents the wells sampled in 1995 and those sampled in 2005/2006 split up by AOC. It should be noted that the distribution of wells among AOCs shown in Table 2-8 is different than what was presented in the OU-3 RI report (M&E, 1997) due to consideration of potential cleanup options. Furthermore, some wells associated with an AOC may actually be upgradient or sidegradient to an AOC.

A summary of PRG exceedances in all wells sampled in 2005/2006 is provided in Table 2-9. A total of 42 common monitoring wells were sampled during both RI sampling events in 1995 and during the 2005/2006 sampling round, with 30 wells screened in the overburden and 12 wells screened in bedrock. Table 2-10 presents a comparison of 1995 and 2005/2006 sampling results when evaluated against current PRGs.

Similar to historical monitoring results, arsenic and manganese PRG exceedances were noted in every AOC across the entire site in the 2005/2006 sampling results. Most metals concentrations were of similar magnitude to historical results, and it should be noted that the OU-3 FS report indicated that attainment of cleanup goals for metals at the site could take a significant number of years (estimated to be > 200; M&E, 2004).

During the 2005/2006 investigation chlorinated VOCs were detected in wells in every AOC, except the B&M Locomotive Shop Disposal Areas (A&B). However, exceedances of PRGs for chlorinated VOCs were noted in less than 20 percent of all wells sampled site-wide. Chlorinated VOCs exceeding PRGs include 1,2-dichloroethane (1,2-DCA), 1,4-dichlorobenzene, carbon tetrachloride, cis-1,3-dichloropropene, tetrachloroethene (PCE), and trichloroethene (TCE).

Based on the carbon tetrachloride concentrations in MW-202S (120 µg/L), OW-38 (37 µg/L) and OW-20 (7.8 µg/L), along with the groundwater flow direction estimated in 2006 (see Figure 2-2), it is possible that the detections are related.

One semi-volatile organic compound (SVOC), bis(2-chloroethyl)ether), and one pesticide, dieldrin, were detected in groundwater samples collected during the 2005/2006 investigation at concentrations that exceed risk-based PRGs. These exceedances occurred in newly-installed wells associated with the Asbestos Landfill and its vicinity (including upgradient locations). No SVOCs or pesticides were found to exceed PRGs in the samples collected during the RI sampling events. However, improved analytical quantification may explain this occurrence, as many more SVOCs were detected in 2005/2006 compared to 1995.

Benzene was detected at a concentration above the PRG in two locations associated with the Asbestos Landfill during the 2005/2006 investigation: OW-08 (59 µg/L) and MW-307S (6.6 µg/L). Benzene was detected at a higher concentration in OW-08 (345 µg/L) during the RI sampling events.

Table 2-11 presents the original rationale for selection of sampling locations during the 2005/2006 sampling event and a summary of the notable results/changes at those locations, grouped by AOC.

Although the MW-01 cluster (MW-01, -01A, -01B, and -01C) and the OW-49 to -51 cluster in the northeast area of the site show PRG exceedances at the edge of or outside of the compliance boundary (see Figures 2-2 and 2-3), the groundwater in this area is assumed to not require remediation. The groundwater flow direction in this area is away from any residential areas and discharging to local wetlands/surface water bodies. Both the human health and ecological risk assessments have determined that surface water exposure does not result in unacceptable risk.

Sediment. Figure 2-4 presents the assumed extent of sediment potentially requiring remediation. Sampling locations with historical PRG exceedances are presented in Appendix A-2. Evaluation of

these exceedances, as well as areas of the site for which there exists no historical sampling, resulted in the extent presented on the figure. Pre-design sampling is anticipated to be performed to better define extent of PRG exceedances. As there are limited data in B&M pond, the extent of wetland area requiring remediation has been estimated to allow for the expectation of finding areas where contaminants do not exceed PRGs. Furthermore, remedial actions performed at AOC 1 (B&M Railroad Landfill) are expected to encompass some of the wetlands on the western side of the pond. An additional on-site unnamed stream, located directly north of the Old B&M Oil/Sludge Recycling Area and discharging into the Middlesex Canal, was also included due to detections in one historic sampling round (June 1993). This stream has not been sampled since that round, but has been visually observed during site investigations to be adversely impacted and is physically similar in function and value to portions of Unnamed Brook. As noted, however, pre-design sampling may determine that historic PRG exceedances no longer exist in this stream.

For B&M Pond, the depth of contaminated sediment requiring remediation is assumed to be 0.5 feet. Remediation alternatives implementing excavation of sediments are assumed to excavate sediments down to 1 foot. These volume estimates have been included in Table 2-7.

2.4 GENERAL RESPONSE ACTIONS

General response actions (GRAs) are developed to satisfy the RAOs for the site. The range of applicable general response actions for each medium/area of concern's RAOs are as follows:

Groundwater:

- No Action
- Institutional Actions

Sediment:

- No Action
- Institutional Actions
- Source Control (capping/containment)
- Source Control (excavation/dredging)
- Source Control (on-site disposal)

Treatment: Off-Site
Treatment: In-Situ
Treatment: On-Site

No remedial activities would be implemented under the No Action response action. However, per the NCP and RI/FS guidance, it is considered throughout the FS process as a baseline against which other alternatives can be compared.

2.5 IDENTIFICATION AND SCREENING OF TECHNOLOGY TYPES AND PROCESS OPTIONS

A preliminary list of potential remedial technologies has been developed for each of the general response actions listed in Section 2.4. These remedial technologies and associated process options are presented and screened in this subsection. Several factors were used to determine feasibility and, in turn, to screen out those technologies that clearly should not be considered for use at the site. The factors used in this screening process were based on the current EPA guidance for conducting RI/FSs under CERCLA and included, but were not limited to, the following:

- \$ Effectiveness in handling the estimated areas or volumes of media and in meeting the PRGs
- \$ Potential impacts to human health and the environment during construction and implementation
- \$ Proven effectiveness and reliability with respect to the contaminants and conditions at the site
- \$ Implementability in terms of both the technical and administrative feasibility
- \$ Relative costs as far as technologies or process options that accomplish the same result

Table 2-12 presents technology and process option screening for groundwater. Table 2-13 presents technology and process option screening for sediment. Each table presents a brief technology description and the justification for the elimination or further consideration of each technology.

SECTION 3.0

DEVELOPMENT OF REMEDIAL ALTERNATIVES

Site-specific remedial alternatives for groundwater and sediment are developed in Sections 3.1 and 3.2, respectively. Remedial technologies not screened from further consideration in Section 2.5 have been used as the basis for developing potential site-specific remedial alternatives listed in this section. The feasible technologies and process options have been combined into comprehensive site remedial alternatives that address the remedial action objectives (RAOs) detailed in Section 2.2.

3.1 GROUNDWATER

The remedial alternatives for groundwater are discussed below and summarized on Table 3-1. Further details are provided in Section 5.0 (Detailed Evaluation) for those alternatives which survive the screening process (Section 4.0).

Alternative GW-1: No Action

This alternative is developed as a baseline for comparison to other alternatives in accordance with the NCP (U.S. EPA, 1990) and RI/FS guidance (U.S. EPA, 1988). No remedial action occurs in this alternative, except for statutorily required five-year reviews.

Alternative GW-2: Limited Action

Under this alternative, groundwater monitoring would be utilized to confirm that contaminants do not migrate beyond the compliance boundary for any waste management area or into any area of potable groundwater. While Monitored Natural Attenuation (MNA) is not specified as a remedy for the site, there is some evidence that natural attenuation of certain contaminants has been occurring at the site (M&E, 2006b; M&E, 2008b). Groundwater sampling would include MNA parameters in an attempt to develop stronger evidence showing that some contaminants/areas of the site may be attenuating naturally. Institutional Controls (ICs) would be implemented to restrict groundwater use as a potable water supply within the compliance boundary. As contaminants remain on site, five-year site reviews would be conducted to evaluate the remedy per EPA guidance.

3.2 SEDIMENT

The remedial alternatives for sediment are discussed below and summarized on Table 3-2. Further details are provided in Section 5.0 (Detailed Evaluation) for those alternatives which survive the screening process (Section 4.0).

Alternative SD-1: No Action

This alternative is developed as a baseline for comparison to other alternatives in accordance with the NCP (U.S. EPA, 1990) and RI/FS guidance (U.S. EPA, 1988). No remedial action occurs in this alternative, except for statutorily required five-year reviews.

Alternative SD-2: Monitored Natural Recovery (MNR)

Under this alternative, MNR would be established as the primary remedy component. Pre-design evaluation would be necessary to determine if MNR alone will achieve PRGs within a reasonable amount of time. This alternative involves evaluation and monitoring of additional parameters (*e.g.*, sediment types, erosion, and deposition) than those associated with chemistry monitoring. Storm water runoff controls would also be implemented to prevent sediment recontamination. As contaminants remain on site, five-year site reviews would be conducted to evaluate the remedy per EPA guidance. For this alternative, the five-year reviews are critical to determine if contaminant concentrations are being reduced effectively.

Alternative SD-3: Source Control - In-situ Capping

This alternative would cover contaminated sediments in B&M Pond with either natural sediments or an engineered cap. This alternative would prevent direct exposure of ecological receptors to the contaminants. Wetland mitigation due to disturbance during cap construction would be performed, as well as wetland/flood storage capacity replacement via excavation of nearby/surrounding sediments. Periodic monitoring, including MNR parameters, of areas/residuals outside of the cap, including Unnamed Brook, would be performed. Maintenance of the cap would be required over time. Storm water runoff controls would also be implemented to prevent sediment recontamination. As

contaminants will remain in place, five-year site reviews would be conducted to evaluate the remedy per EPA guidance.

Alternative SD-4: Source Control – Excavation (B&M Pond) with Disposal

This alternative would involve excavating contaminated sediments in B&M Pond through either dredging or dry excavation techniques. Wetland mitigation due to disturbance during excavation would be performed, including replacement of excavated sediments with appropriate clean fill. Following dewatering, sediments would be transported to a disposal location; either an off-site facility or an on-site area (*e.g.*, one of the OU-3 AOCs) and placed under a cap. Depending on timing of cap design/placement for those on-site areas, use of this option may be limited. An MNR monitoring program for areas/residuals outside of the excavation, including Unnamed Brook, would also be established. Storm water runoff controls would also be implemented to prevent sediment recontamination. Five-year site reviews would be conducted to evaluate the remedy per EPA guidance.

Alternative SD-5: Source Control - Excavation with On-site Treatment - Chemical Extraction/Soil Washing

This alternative is similar to Alternative SD-4, except that excavated sediments would be treated on-site via chemical extraction/soil washing methods. Pre-design testing would be necessary to determine the appropriate contaminant removal techniques. Following treatment, the sediments would be utilized as fill in the excavated areas. Disposal of wash water, which would require further treatment, is assumed to be performed via groundwater injection.

Alternative SD-6: Source Control – Excavation (B&M Pond and Unnamed Brook) with Disposal

This alternative is similar to Alternative SD-4, except that excavation would also include Unnamed Brook and is assumed to remove contaminants such that an MNR monitoring program would not be necessary.

SECTION 4.0

SCREENING OF REMEDIAL ALTERNATIVES

Initial screening of remedial alternatives developed in Section 3.0 is performed in this section to initiate the evaluation of each alternative, specific to each medium and area of concern. In addition, the screening process is used to potentially eliminate one or more alternatives that do not appear advantageous to carry through to the detailed evaluation in Section 5.0. This initial screening process includes an assessment of the advantages and disadvantages of each alternative on the basis of their effectiveness, implementability, and cost, in accordance with the RI/FS guidance (U.S. EPA, 1988).

The effectiveness of each remedial alternative was assessed using the following criteria:

- overall protection of human health and the environment
- compliance with ARARs
- long-term effectiveness and permanence
- reductions in toxicity, mobility, and volume through treatment
- short-term effectiveness

The implementability of each remedial alternative was assessed using the following criteria:

- technical feasibility
- administrative feasibility
- applicability based on site conditions and layout

The costs were initially assessed using engineering judgment, considering capital costs for equipment and construction and operation and maintenance (O&M) estimates. Information from the OU-3 FS (M&E, 2004) was also utilized in performing the screening.

4.1 GROUNDWATER

As there are only two remedial alternatives related to groundwater (GW-1: No Action and GW-2: Limited Action), screening was not performed and both alternatives have been retained for detailed evaluation.

4.2 SEDIMENT

Tables 4-1 through 4-6 present the initial screening of the remedial alternatives for the sediment in Unnamed Brook, B&M Pond, and their respective associated wetlands. Based on this screening, alternatives SD-1, SD-4, and SD-6 were retained for detailed evaluation. SD-2 was removed from further evaluation due to the lack of lines of evidence of MNR occurring in the areas of highest contamination in B&M Pond. SD-3 was removed from further evaluation due to the anticipated significant wetland alterations which would be expected due to the loss of flood storage capacity resulting from cap construction. SD-5 was removed from further evaluation due to the anticipated high capital cost related to wash water treatment.

SECTION 5.0

DETAILED EVALUATION OF THE REMEDIAL ALTERNATIVES

Detailed evaluation of the alternatives remaining after screening is needed to provide decision-makers with the necessary information to compare remedial alternatives and select an appropriate remedy for the site that demonstrates satisfaction of the CERCLA requirements. Nine evaluation criteria have been developed to address the CERCLA requirements and to address the additional technical and policy considerations that have proven to be important for selecting amongst remedial alternatives. These evaluation criteria serve as the basis for conducting the detailed analyses during the FS and for subsequently selecting an appropriate remedial action as part of the Record of Decision. These nine feasibility study criteria are as follows:

- overall protection of human health and the environment
- compliance with Applicable, or Relevant and Appropriate Requirements (ARARs)
- long-term effectiveness and permanence
- reduction of toxicity, mobility or volume
- short-term effectiveness
- implementability
- cost
- state acceptance
- community acceptance

A detailed discussion of the specific attributes of each FS criterion is presented in Table 5-1. The final two criteria, State and community acceptance, are addressed in the ROD once formal comments on the proposed plan have been received.

The following sections present the detailed evaluation of each of the remaining remedial alternatives.

5.1 GROUNDWATER

Two alternatives remain from the screening process for site-wide groundwater: no action and limited action.

The descriptions and costs presented below are based on existing data and knowledge of the site groundwater. However, it should be noted that development of these alternatives is based primarily on data/information gathered prior to OU-3 source control actions.

5.1.1 GW-1: No Action

Alternative GW-1, by regulatory definition, is the “No Action” alternative required by the NCP and EPAs feasibility study guidance (U.S. EPA, 1988). No remedial actions (including monitoring) will be conducted in relation to the site-wide groundwater under this alternative. Therefore, only naturally-occurring processes would be working towards achieving RAOs. Uncontrolled groundwater contamination may still exist and no measures would be taken to prevent use of this groundwater, limit the extent of the contamination, or identify changes in the extent of the contamination. Five-year reviews of the remedy would still be required by CERCLA, because of waste being left in place.

Cost. No action would be performed under this alternative, therefore no costs are presented other than the periodic cost of conducting the five-year reviews.

Alternative Evaluation. The detailed analysis of GW-1 compared to the evaluation criteria is presented in Table 5-2.

5.1.2 GW-2: Limited Action

Under this alternative, groundwater monitoring would be utilized to confirm that contaminants do not migrate beyond the compliance boundary for any waste management area or into any area of potable groundwater. Monitored natural attenuation (MNA) parameters would be included in the monitoring program to establish whether natural attenuation may be occurring for some groundwater contaminants. Institutional Controls (ICs) would be implemented to restrict groundwater use as a

potable water supply. Five-year reviews of the remedy would still be required by CERCLA, because of waste being left in place.

The major components of this alternative include monitoring well installation, environmental monitoring, ICs, and five-year reviews.

Monitoring Well Installation. Under this alternative, it is assumed that up to 15 new monitoring wells would be installed to confirm that the contaminated groundwater is not migrating beyond the site's compliance boundary. These wells would primarily be installed in the bedrock flow zone, because bedrock groundwater could potentially migrate off-site via fractures, while overburden groundwater appears to be limited in migration by surrounding waterbodies and wetlands.

Environmental Monitoring. Environmental monitoring would be performed in order to confirm that contaminated groundwater is not migrating beyond the site's compliance boundary. For cost estimating purposes, it is assumed that groundwater monitoring would consist of collecting samples from a total of 40 site wells. The monitoring would be performed quarterly for the first year after implementation with annual sampling thereafter. Analytical parameters include VOCs, SVOCs, metals, pesticides, MNA parameters, and water quality parameters (see Appendix B).

ICs. Institutional controls are administrative actions that minimize the potential for human exposure by restricting resource usage. Institutional controls would be implemented in the form of the establishment of a groundwater compliance boundary, under applicable standards, and water use deed restrictions (i.e., limitations on groundwater use as potable water) to prevent exposure to contaminated groundwater. The preliminary compliance zone boundary is presented on Figure 2-1. Discussions with appropriate local and state authorities will occur to inform them that future installation of any nearby private or public wells should first evaluate potential impacts both to and due to the site.

Five-Year Site Reviews. As contaminants will remain on-site in site-wide groundwater, five-year site reviews would be conducted to evaluate the remedy per EPA guidance. Environmental monitoring data would be reviewed to analyze changes in contamination and evaluate if the remedy is progressing. Additional actions may be implemented, if necessary, as a result of these reviews or if regulatory or

statutory standards for cleanup change.

Cost. For alternative GW-2, the cost estimate includes capital costs, O&M costs, and periodic costs. Capital costs include those associated with installation of new monitoring wells and establishing ICs. O&M costs include those associated with environmental monitoring. Periodic costs would include five-year review reports, decommissioning of monitoring wells, and removal of remedy components at completion of operation. Although the length of remedy operation is not clear, 30 years has been assumed for costing purposes. Note that modeling based on existing site information shows that some contaminants will be reduced to PRGs in less than 30 years, while others (metals) could take more than 200 years (M&E, 2004). However, only further monitoring will be able to determine a better estimate of operation time.

Alternative Evaluation. The detailed analysis of GW-2 compared to the evaluation criteria is presented in Table 5-3.

5.2 SEDIMENT

Four alternatives remain from the screening process for sediment remediation: no action, excavation (B&M Pond) with disposal, and excavation (B&M Pond and Unnamed Brook) with disposal.

The descriptions and costs presented below are based on existing data and knowledge of the existing sediment in Unnamed Brook and B&M Pond. However, it should be noted that development of these alternatives is based primarily on data/information gathered prior to OU-3 source control actions.

5.2.1 SD-1: No Action

Alternative SD-1, by regulatory definition, is the “No Action” alternative required by the NCP and EPA’s feasibility study guidance (U.S. EPA, 1988). No remedial actions (including monitoring) will be conducted under this alternative. Five-year reviews of the remedy would still be required by CERCLA, because of waste being left in place.

Cost. No action will be performed under this alternative, therefore no costs are presented except for the cost of conducting the five-year reviews.

Alternative Evaluation. The detailed analysis of SD-1 compared to the evaluation criteria is presented in Table 5-4.

5.2.2 SD-4: Source Control - Excavation (B&M Pond) with Disposal

This alternative would involve excavating contaminated sediments in B&M Pond through either dredging or dry excavation techniques. Pre-design sampling would be performed to determine/define both horizontal and vertical extent of the excavation area, as well as to confirm that MNR processes will continue to reduce contaminants in Unnamed Brook (and other areas outside of the excavation) at a rate which will achieve PRGs in a reasonable amount of time. Wetland mitigation due to disturbance during excavation would be performed, including replacement of excavated sediments with appropriate clean fill. Following dewatering, sediments would be transported to an off-site disposal facility, or possibly moved to an on-site area (*e.g.*, one of the OU-3 AOCs) and placed under a cap. Depending on timing of cap design/placement for those on-site areas, use of this option may be limited.

Areas/residuals outside of the excavation, including within the Unnamed Brook, would be monitored as part of a MNR program. Storm water runoff controls (such as curbing/berms and filters) would also be implemented to prevent sediment recontamination. As contaminants will remain in place, five-year site reviews would be conducted to evaluate the remedy per EPA guidance.

Excavation. For the purpose of this FS, it is assumed that sediment will be excavated from B&M Pond through dredging or dry excavation techniques. Temporary access roadways would be needed and erosion control measures would be implemented prior to excavation. A silt curtain may be needed to control migration of suspended particles. Excavated sediments would be dewatered on-site prior to disposal and water generated from dewatering on a staging pad would require disposal. Wetland mitigation due to disturbance during excavation would be performed, including replacement of excavated sediments with appropriate clean fill.

Disposal. As described above, there is the possibility of disposal of excavated sediments under a future on-site cap for one of the OU-3 AOCs; however, the timing of cap design/placement may limit this option. Therefore, for cost purposes, it is assumed that sediments would be transported to an off-site disposal facility following dewatering.

MNR. Natural recovery is defined as, "...a remedy for contaminated sediment that typically uses ongoing, naturally occurring processes to contain, destroy, or reduce the bioavailability or toxicity of contaminants in sediment" (U.S. EPA, 2005). MNR typically involves leaving contaminated sediments in place and allowing ongoing aquatic, sedimentary, and biological processes to reduce the bioavailability of the contaminants in order to protect ecological and/or human receptors. Natural processes of interest associated with MNR include physical processes, biological processes, and chemical processes. Physical processes include sedimentation, such as burial of contamination, advection, diffusion, dilution, dispersion, bioturbation, and volatilization; biological processes include biodegradation, biotransformation, phytoremediation, and biological stabilization; and chemical processes include oxidation/reduction, sorption, or other processes resulting in stabilization or reduced bioavailability. For example, the discussion of the data in Section 1.4.1 for the Unnamed Brook and its wetland would suggest such processes are at work and MNR is expected to meet the established PRGs within a particular time frame. Evaluation of available monitoring results shows that contaminant concentrations in Unnamed Brook may achieve PRGs via MNR in less than 15 years (see Appendix B). Acquisition of information over time is critical in order to confirm that the risk-reduction processes are occurring as expected (U.S. EPA, 2005). Pre-design investigations would be performed to confirm that MNR will achieve PRGs in a reasonable amount of time in areas outside of the excavation.

Environmental Monitoring. Since MNR would be established as the primary remedy for areas outside of the excavation, including Unnamed Brook, under this alternative, environmental monitoring would be performed in order to evaluate the progress/success of the remedy. For cost estimating purposes, it is assumed that monitoring would consist of collecting sediment samples semi-annually from a total of 10 locations outside the excavation area (within the B&M Pond wetland) and within Unnamed Brook. Chemical analysis parameters include PCBs, PAHs, metals, pesticides, and TOC. Monitoring would also be performed for additional parameters (*e.g.*, sediment types, erosion, and

deposition) to allow for MNR evaluations.

Five-Year Site Reviews. As sediments outside of the excavation area would be monitored, contaminants would remain in place and five-year site reviews would be conducted to evaluate the remedy per EPA guidance. Environmental monitoring data would be reviewed to analyze changes in contamination and evaluate if the remedy is progressing towards achieving RAOs. Additional actions may be implemented if necessary as a result of these reviews or if regulatory or statutory standards for cleanup change.

Cost. For alternative SD-4, the cost estimate includes capital costs, O&M costs, and periodic costs. Capital costs consist of direct and indirect costs initially incurred to develop, design, and implement the remedial alternative. For the purpose of this cost estimate, it is assumed that dewatered sediments will be disposed of off-site. O&M costs would include those associated with environmental monitoring outside of the excavation area. Periodic costs would include five-year review reports. Assuming MNR is occurring at a reasonable rate, 20 years of monitoring has been assumed for costing purposes (see Appendix B for estimate of MNR time frame). Further monitoring will be able to determine a better estimate of operation time.

Alternative Evaluation. The detailed analysis of SD-4 compared to the evaluation criteria is presented in Table 5-5.

5.2.3 SD-6: Source Control - Excavation (B&M Pond and Unnamed Brook) with Disposal

This alternative is similar to Alternative SD-4, except that excavation would also include Unnamed Brook and is assumed to remove contaminants such that an MNR monitoring program would not be necessary. Pre-design sampling would be performed to determine/define both horizontal and vertical extent of the excavation area. Wetland mitigation due to disturbance during excavation would be performed, including replacement of excavated sediments with appropriate clean fill. Following dewatering, sediments would be transported to an off-site disposal facility, or possibly moved to an on-site area (*e.g.*, one of the OU-3 AOCs) and placed under a cap. Depending on timing of cap

design/placement for those on-site areas, use of this option may be limited. Storm water runoff controls (such as curbing/berms and filters) would also be implemented to prevent sediment recontamination.

Excavation. For the purpose of this FS, it is assumed that sediment will be excavated from B&M Pond and Unnamed Brook through dredging or dry excavation techniques. Temporary access roadways would be needed and erosion control measures would be implemented prior to excavation. A silt curtain may be needed to control migration of suspended particles. Excavated sediments would be dewatered on-site prior to disposal and water generated from dewatering on a staging pad would require disposal. Wetland mitigation due to disturbance during excavation would be performed, including replacement of excavated sediments with appropriate clean fill.

Disposal. As described above, there is the possibility of disposal of excavated sediments under a future on-site cap for one of the OU-3 AOCs; however, the timing of cap design/placement may limit this option. Therefore, for cost purposes, it is assumed that sediments would be transported to an off-site disposal facility following dewatering.

Cost. For alternative SD-6, the cost estimate includes only capital costs. Capital costs consist of direct and indirect costs initially incurred to develop, design, and implement the remedial alternative. For the purpose of this cost estimate, it is assumed that dewatered sediments will be disposed of off-site.

Alternative Evaluation. The detailed analysis of SD-6 compared to the evaluation criteria is presented in Table 5-6.

SECTION 6.0

COMPARATIVE ANALYSIS

In the sections that follow, a comparative analysis of the alternative proposed for each medium/area of concern is presented. The comparative analysis evaluates the relative performance of each of the alternatives presented in Section 5.0 versus nine feasibility study criteria. Advantages and disadvantages of each alternative are described in detail.

Overall protection of human health and the environment and compliance with ARARs are the two threshold criteria that must be met by any alternative in order for it to be selected as a proposed remedy. The next five FS criteria (i.e., long-term effectiveness and permanence, reduction of toxicity, mobility and volume through treatment, short-term effectiveness, implementability, and cost) are used to differentiate among the remaining alternatives that meet the threshold criteria. The final two criteria, State and community acceptance, are addressed in the ROD once formal comments on the proposed plan have been received.

6.1 GROUNDWATER

Table 6-1 presents a summary of the primary evaluation factors and a comparative assessment of the alternatives evaluated for site-wide groundwater. The alternatives for remediation include:

- No Action;
- Limited Action;

6.1.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment, within the limits of the remedial action objectives defined for this feasibility study, is a key threshold criterion that must be attained by an alternative to be eligible for selection in the ROD. This section describes the overall assessment of whether each alternative achieves adequate protection of human health and the environment.

6.1.1.1 Human Health Protection. As noted in Section 2.0, there are potential human health risks due to VOCs, SVOCs, pesticides, and metals in groundwater. The No Action alternative would not be protective of human health, since risks posed by the contaminated groundwater would not be addressed. The Limited Action alternative would be protective of human health as long as ICs are enforced such that contaminated groundwater from the site does not migrate beyond the compliance boundary.

6.1.1.2 Ecological Protection. There are no significant ecological risks noted to be associated with the groundwater.

6.1.2 Compliance With ARARs

Appendix C, Tables C-1 to C-2 list the ARARs for the two groundwater alternatives. There are four EPA risk guidances that are To Be Considered that establish the human health risks posed by groundwater contaminants. By not taking any action under the No Action alternative, it will not be possible to determine if the alternative achieves any of the Chemical-specific TBC standards. Under the Limited Action alternative, monitoring will be performed to ensure that groundwater exceeding risk standards does not migrate beyond the compliance boundary for the site.

There are no location- or action-specific ARARs for the No Action Alternative. Location-specific ARARs for the Limited Action alternative pertain to wetland and floodplain resources within the area of the contaminated groundwater plume that may be affected by monitoring well installation and operation. There also are location-specific standards for consultation on fish and wildlife impacts from the remedial activities for the Limited Action alternative. Requirements of the location-specific ARARs noted will be fulfilled.

Action-specific ARARs for the Limited Action alternative address groundwater monitoring standards under the Federal Safe Drinking Water Act and State drinking water standards to ensure that contaminated groundwater is not migrating beyond the compliance boundary and institutional control standards to make sure adjacent properties to the site do not install wells that

will draw contaminated groundwater beyond the compliance boundary.

6.1.3 Long-Term Effectiveness and Permanence

This section summarizes the evaluation for risks remaining at the site after RAOs have been met, and for risks from management of residuals.

6.1.3.1 Magnitude of Residual Risk: Human Health. The residual risk will not change under the No Action alternative and will primarily be reduced only by that which attenuates naturally under the Limited Action alternative. ICs would be protective against accessing the groundwater as a potable water supply and would be maintained until all groundwater cleanup standards are achieved.

6.1.3.2 Magnitude of Residual Risk: Ecological. There are no significant ecological risks noted to be associated with the groundwater.

6.1.4 Reduction of Toxicity, Mobility and Volume Through Treatment

This section provides a comparison of the alternatives selected; quantities of waste materials to be remediated; expected reductions in toxicity, mobility and volume; and residuals following treatment alternatives.

The alternatives evaluated do not utilize treatment processes. Therefore, the criteria for treatment have not been evaluated.

6.1.5 Short-Term Effectiveness

The effectiveness of the remedial alternatives during construction and implementation are compared to one another in the following paragraphs.

6.1.5.1 Protection of Community and Workers During Remedial Actions. Short-term risks include any additional risks to the community or workers at the site from exposures to COCs as a result of construction measures and implementation of remedial activities. There will be no additional short-term risks from exposures under the No Action alternative.

The Limited Action alternative will have a nominal increase of short-term risks to the community and workers due to environmental monitoring. Air sampling and monitoring will be used as necessary to evaluate any potential risks to the community from potential inhalation exposures during well installation. Concentrations of COCs are expected to be limited, but greatest on-site. Therefore, workers at the site will use appropriate PPE to mitigate any potential risks from exposures to COCs.

6.1.5.2 Environmental Impacts. The remedial technologies evaluated differ in the magnitude of the potential impacts to natural habitats. There will be no short-term habitat impacts resulting from the No Action alternative. The Limited Action alternative will result in temporary and minor habitat impact due to monitoring well installation. If any component of the monitoring program, including monitoring well installation and accessing monitoring locations, are within federal jurisdictional wetlands or floodplains, measures will be taken to minimize impacts and meet requirements of Federal Executive Order #11900 (Protection of Wetlands) and Executive Order #11988 (Management of Floodplains).

6.1.5.3 Time Until Remedial Action Objectives are Achieved. Under the No Action alternative, achieving RAOs would be dependent on natural processes in the subsurface. Without monitoring it is not possible to assess the criteria. However, based on previous modeling (M&E, 2004), the time frame would be greater than 30 years. For the Limited Action alternative, RAOs associated with preventing direct contact exposures to groundwater by future residential receptors would be assumed to be achieved upon implementation of ICs (likely less than five years). The time frame for site close-out, based on achieving PRGs, is expected to be greater than 30 years, based on previous modeling (M&E, 2004).

6.1.6 Implementability

The alternatives with the highest degree of implementability would have the following characteristics from EPA's FS guidance (U.S. EPA, 1988):

- require the lowest effort to construct, operate and maintain the technologies
- include or consist only of the highest or most reliable technologies
- require the lowest effort to undertake additional remedial actions, if necessary
- include the fewest administrative hurdles for obtaining necessary permits, approvals and agreements
- rely only minimally on off-site treatment, storage, and disposal facility services (TSDFs)
- require the least amount or quantity of necessary specialized equipment and/or personnel specialists
- utilize commonly available technologies to the largest degree

Conversely, alternatives with lesser degrees of implementability will have lesser degrees of the characteristics discussed above. The first three bullets define the "technical feasibility" with regard to implementability of the alternative, the fourth bullet defines "administrative feasibility," and the remaining three bullets define the "availability of services and materials" with respect to the alternative. These three factors combine to provide the overall degree of implementability of the alternative. After evaluating all alternatives and combining the technical feasibility, administrative feasibility and availability of services and materials evaluations, the overall implementability comparison shows that both the No Action and Limited Action alternatives have a high degree of overall implementability.

In general, more complex remedial technologies are more difficult to implement and will have lesser degrees of overall implementability compared to other, less complex, alternatives. As a result, the No Action alternative is typically considered the most implementable, and any additional alternatives are less implementable.

Sections 6.1.6.1, 6.1.6.2, and 6.1.6.3 present more detailed evaluations of the comparison of implementability characteristics of the remedial alternatives for which this analysis was performed.

6.1.6.1 Technical Feasibility. Implementability with regard to the technical feasibility of an

alternative includes an evaluation of three factors: 1) ability to construct, operate and maintain the technologies, 2) the reliability of the technologies, and 3) the ease of undertaking additional remedial actions, if warranted by site conditions determined after implementation of the remedy. Each of these three factors is described for the alternatives evaluated.

The ability to construct, operate and maintain the technologies associated with each remedial alternative is proportional to the degree or intensity of each remedy. Alternatives which use more intensive remedial technologies such as containment and in-situ or on-site treatments will have the greatest difficulty in implementing construction and O&M. Conversely, alternatives which utilize less intensive technologies, such as institutional actions, will be easier to implement. The No Action and Limited Action alternatives are both easy to implement, with the Limited Action alternative having a couple of low-intensity activities (monitoring and establishing ICs) to implement.

The reliability criterion does not apply to the No Action alternative because it includes no activity or procedures with which to assess reliability. The Limited Action alternative contains remedial technologies that can be considered “reliable” in terms of relying or counting on the day-to-day functioning of the remedy as intended. This assessment is dependent on the assumption that proper monitoring techniques and IC enforcement are appropriately performed.

In terms of achieving the remedial action objectives, however, the reliability of an alternative is often proportional to the greater intensity of the remedial actions contained in the alternative. The Limited Action alternative is reliable in achieving the RAO associated with preventing direct contact exposures to groundwater by future residential receptors as long as ICs are properly enforced.

The ease of undertaking additional remedial actions, if warranted by future site conditions or requirements, is also proportional to the degree or intensity of each remedy. Alternatives that use more intensive remedial technologies such as containment, in-situ, or on-site treatment remedies will have the greatest difficulty in undertaking and implementing additional remedial actions.

Conversely, alternatives which utilize less intensive technologies such as institutional actions can more easily implement additional remedial actions. Both of the alternatives presented allow for low effort to implement additional, future remedial actions.

6.1.6.2 Administrative Feasibility. The No Action alternative has the fewest administrative issues to address and only includes five-year reviews, which are easily administered. Therefore, this alternative has the highest degree of administrative feasibility. The Limited Action alternative has some administrative issues pertaining to establishing ICs on-site to prevent groundwater use and off-site to prevent the installation of wells that could draw contaminated groundwater from the site (potentially would involve the Town adopting an ordinance).

6.1.6.3 Availability of Services and Materials. Implementability with regard to the availability of services and materials includes an evaluation of three factors: 1) availability or usage of off-site treatment, storage, and disposal facilities (TSDFs), 2) availability of necessary or specialized equipment or specialist personnel needed to implement the alternative, and 3) availability of prospective technologies required by the alternative. Each of these three factors is described for the alternatives.

Neither alternative would require use of off-site TSDF services. Other services and materials are easy to obtain and environmental monitoring performed as part of the Limited Action alternative does not require any special technologies.

6.1.7 Cost

The No Action alternative would only incur costs for conducting five-year reviews (\$24,800). The Limited Action alternative will require O&M (environmental monitoring) for at least 30 years. The total net present worth costs (capital plus O&M and periodic costs over the duration of the remedial action) for the Limited Action alternative is \$1.3 million. It should be noted that costs for both alternatives are based on a 30 year period, but that, based on previous modeling (M&E, 2004), the time frame prior to site close-out will likely be much longer than 30 years,

resulting in higher overall costs. Cost sensitivity analysis is provided in Appendix B.

6.1.8 State Acceptance

Acceptance of the selected alternative for this medium by the Commonwealth of Massachusetts will be determined during the public review and comment period for the Proposed Plan.

6.1.9 Community Acceptance

Acceptance of the selected alternative for this medium by the community, including the Town Billerica, will be determined during the public review and comment period for the Proposed Plan.

6.2 SEDIMENT

Table 6-2 presents a summary of the primary evaluation factors and a comparative assessment of the alternatives evaluated for sediments in Unnamed Brook and B&M Pond. The alternatives for remediation of sediment include:

- No Action;
- Source Control – Excavation (B&M Pond) with Disposal; and
- Source Control – Excavation (B&M Pond and Unnamed Brook) with Disposal.

The second alternative involves reduction of contaminants in areas outside of the excavation, including Unnamed Brook, via MNR. In the following comparative analysis, this alternative will be classified as the “Partial Excavation” alternative, while the third alternative will be classified as the “Full Excavation” alternative.

6.2.1 Overall Protection of Human Health and the Environment

Overall protection of human health and the environment, within the limits of the remedial action objectives defined for this feasibility study, is a key threshold criterion that must be attained by an

alternative to be eligible for selection in the ROD. This section describes the overall assessment of whether each alternative achieves adequate protection of human health and the environment.

6.2.1.1 Human Health Protection. There are no unacceptable human health risks noted to be associated with the site sediment.

6.2.1.2 Ecological Protection. As noted in Section 2.0, there are potential ecological risks due to PAHs, PCBs, pesticides, and metals in sediment. The No Action alternative would not be protective of the environment, since risks posed by the contaminated sediment would not be addressed. The two excavation alternatives would be protective of ecological receptors since contaminated sediments exceeding ecological risk levels will be removed. The Partial Excavation alternative which also relies on MNR will be protective since an estimate of the time frame to achieve PRGs is less than 20 years (see Appendix B).

Primary ARARs associated with ecological protection include Federal Executive Order #11900 (Protection of Wetlands) and Executive Order #11988 (Management of Floodplains). The No Action alternative does not address the contamination which has degraded the wetlands; however, it also does not include remedial activities which would require further mitigation due to wetland and floodplain impacts. The two excavation alternatives would both address the contamination which has degraded the wetlands, as well as mitigate wetland and floodplain impacts derived from implementation of the remedy.

6.2.2 Compliance With ARARs

Appendix C, Tables C-3 to C-5 list the ARARs for the four sediment alternatives. The No Action alternative fails to address chemical-specific To Be Considered criteria used to evaluate ecological risk. Under the Partial Excavation alternative, these standards would be complied with following completion of the MNR program (i.e., achievement of PRGs). Similarly, these standards would be complied with for the Full Excavation alternative upon completion of the remedy.

There are no location- or action-specific ARARs for the No Action alternative. Location-specific ARARs for the other alternatives pertain to wetland and floodplain resources, as well as historical resources (e.g., Middlesex Canal), that may be affected by monitoring and excavation activities. There also are location-specific standards for consultation on fish and wildlife impacts from the remedial activities. Requirements of the location-specific ARARs noted will be fulfilled.

Both excavation alternatives will comply with Action-specific ARARs for the implementation of sediment removal. Specific standards address dust control and wetlands protection.

6.2.3 Long-Term Effectiveness and Permanence

This section summarizes the evaluation for risks remaining at the site after RAOs have been met, and for risks from management of residuals.

6.2.3.1 Magnitude of Residual Risk: Human Health. There are no unacceptable human health risks noted to be associated with the site sediment.

6.2.3.2 Magnitude of Residual Risk: Ecological. The residual risk will remain similar to current conditions, beyond any reduction due to natural recovery processes, under the No Action alternative. The Partial Excavation alternative would significantly reduce ecological risks for B&M Pond sediment, where achieving PRGs would reduce residual risk to acceptable levels. Outside of this excavation (including Unnamed Brook), the residual risk is expected to be reduced to acceptable levels over time (currently assumed to be less than 20 years; see Appendix B) as the PRGs are approached/achieved via MNR. The Full Excavation alternative would significantly reduce ecological risks for B&M Pond and Unnamed Brook sediment, where achieving PRGs would reduce residual risk to acceptable levels.

6.2.4 Reduction of Toxicity, Mobility and Volume Through Treatment

This section provides a comparison of the alternatives selected; quantities of waste materials to be

remediated; expected reductions in toxicity, mobility and volume; and residuals following treatment alternatives.

The alternatives evaluated do not utilize treatment processes. Therefore, the criteria for treatment have not been evaluated.

6.2.5 Short-Term Effectiveness

The effectiveness of each remedial alternative during construction and implementation are compared to one another in the following paragraphs.

6.2.5.1 Protection of Community and Workers During Remedial Actions. Short-term risks include any additional risks to the community or workers at the site from exposures to contaminants as a result of construction measures and implementation of remedial activities. There will be no additional short-term risks from exposures under the No Action alternative.

Short-term community risks associated with environmental monitoring for the two excavation alternatives would be minor. However, off-site sediment disposal will result in increased local truck traffic.

Workers at the site will use appropriate PPE to mitigate any potential risks from exposures to sediment contaminants during any monitoring and excavation activities.

6.2.5.2 Environmental Impacts. The remedial technologies evaluated differ in the magnitude of the potential impacts to natural habitats. There would be no short-term habitat impacts resulting from the No Action alternative. Short-term, minor impacts to ecological habitat due to sediment monitoring as part of a MNR program would occur for the Partial Excavation alternative. Additional short-term impacts to ecological habitat would occur as part of both excavation alternatives, but wetland mitigation would be performed.

6.2.5.3 Time Until Remedial Action Objectives are Achieved. The No Action alternative would not achieve RAOs. For the Partial Excavation alternative, achieving RAOs associated with sediment exposure to ecological receptors would be limited by MNR occurring in areas outside of the B&M Pond excavation. Based on available monitoring data, it is assumed that RAOs would be achieved in less than 20 years (see Appendix B). For the Full Excavation alternative, RAOs for sediment would be achieved upon removal of contaminated sediment. This is assumed to be less than five years.

6.2.6 Implementability

The alternatives with the highest degree of implementability would have the following characteristics from EPA's FS guidance (U.S. EPA, 1988):

- require the lowest effort to construct, operate and maintain the technologies
- include or consist only of the highest or most reliable technologies
- require the lowest effort to undertake additional remedial actions, if necessary
- include the fewest administrative hurdles for obtaining necessary permits, approvals and agreements
- rely only minimally on off-site treatment, storage, and disposal facility services (TSDFs)
- require the least amount or quantity of necessary specialized equipment and/or personnel specialists
- utilize commonly available technologies to the largest degree

Conversely, alternatives with lesser degrees of implementability will have lesser degrees of the characteristics discussed above. The first three bullets define the "technical feasibility" with regard to implementability of the alternative, the fourth bullet defines "administrative feasibility," and the remaining three bullets define the "availability of services and materials" with respect to the alternative. These three factors combine to provide the overall degree of implementability of the alternative. After evaluating all alternatives and combining the technical feasibility, administrative feasibility and availability of services and materials evaluations, the overall implementability comparison is as follows:

- The No Action alternative has the highest degree of overall implementability

- Both excavation alternatives have a moderate/high degree of implementability

In general, more complex remedial technologies are more difficult to implement and will have lesser degrees of overall implementability compared to other, less complex, alternatives. As a result, the No Action alternative is the most implementable while the excavation alternatives are less implementable.

Sections 6.2.6.1, 6.2.6.2, and 6.2.6.3 present more detailed evaluations of the comparison of implementability characteristics of the remedial alternatives for which this analysis was performed.

6.2.6.1 Technical Feasibility. Implementability with regard to the technical feasibility of an alternative includes an evaluation of three factors: 1) ability to construct, operate and maintain the technologies, 2) the reliability of the technologies, and 3) the ease of undertaking additional remedial actions, if warranted by site conditions determined after implementation of the remedy. Each of these three factors is described for the alternatives evaluated.

The ability to construct, operate and maintain the technologies associated with each remedial alternative is proportional to the degree or intensity of each remedy. Alternatives which use more intensive remedial technologies such as containment and in-situ or on-site treatments will have the greatest difficulty in implementing construction and O&M. Conversely, alternatives which utilize less intensive technologies, such as institutional actions, will be easier to implement.

Environmental monitoring used in the Partial Excavation alternative is a common practice. Monitoring to evaluate MNR in wetlands can be difficult, but still applies standard evaluation techniques. Excavation of sediments has more design and construction constraints which makes those alternatives more difficult to implement, but it is still a common technology.

Access to the areas requiring excavation may be complex at the site. In both excavation alternatives, access to B&M Pond will likely occur via a roadway over the planned cap for B&M Railroad Landfill (AOC 1 under OU-3), so care will be necessary so as to not damage the cap. Under the Full Excavation, access to Unnamed Brook may be difficult in some areas and diverting the brook may also be necessary. Therefore, the Partial Excavation alternative is considered to be

easier to implement than the Full Excavation alternative.

The reliability criterion does not apply to the No Action alternative because it includes no activity or procedures with which to assess reliability. The remaining two alternatives contain remedial technologies that can be considered “reliable” in terms of relying or counting on the day-to-day functioning of the remedy as intended. Excavation is known to be reliable, dependent on the assumption that proper construction techniques are utilized. Under the Partial Excavation alternative, MNR is expected to be reliable based on available site data. While high flow conditions can both remove contaminants as well as cover sediments, the site streams/water bodies do not appear to achieve flow rates which would reduce the reliability of the MNR portion of that alternative.

In terms of achieving the remedial action objectives, however, the reliability of an alternative is often proportional to the greater intensity of the remedial actions contained in the alternative. Thus, the lowest reliability may be expected in the No Action alternative, while the two excavation alternatives provide a high level of reliability that the remedial action objectives can be achieved.

The ease of undertaking additional remedial actions, if warranted by future site conditions or requirements, is also proportional to the degree or intensity of each remedy. Alternatives that use more intensive remedial technologies such as containment, in-situ, or on-site treatment remedies will have the greatest difficulty in undertaking and implementing additional remedial actions. Conversely, alternatives which utilize less intensive technologies such as institutional actions can more easily implement additional remedial actions. All of the alternatives presented allow for low effort to implement additional, future remedial actions on sediments remaining at the site.

6.2.6.2 Administrative Feasibility. The No Action alternative has the fewest administrative issues to address and only includes five-year reviews, which are easily administered. Therefore, this alternative has the highest degree of administrative feasibility. Both excavation alternatives would require approvals for disposal of contaminated sediment and water from dewatering,

thereby invoking more administrative review.

6.2.6.3 Availability of Services and Materials. Implementability with regard to the availability of services and materials includes an evaluation of three factors: 1) availability or usage of off-site treatment, storage, and disposal facilities (TSDFs), 2) availability of necessary or specialized equipment or specialist personnel needed to implement the alternative, and 3) availability of prospective technologies required by the alternative. Each of these three factors is described for the alternatives.

Both excavation alternatives would require use of off-site TSDF services. Other services and materials are easy to obtain.

6.2.7 Cost

The No Action alternative would only incur costs for conducting five year review (\$24,800).

The total net present worth costs (capital plus O&M over the duration of the remedial action) for the Partial Excavation alternative is \$4.1 million, while the Full Excavation alternative is \$5.4 million. Cost sensitivity analysis is provided in Appendix B.

6.2.8 State Acceptance

Acceptance of the selected alternative for this medium by the Commonwealth of Massachusetts will be determined during the public review and comment period for the Proposed Plan.

6.2.9 Community Acceptance

Acceptance of the selected alternative for this medium by the community, including the Town of Billerica, will be determined during the public review and comment period for the Proposed Plan.

SECTION 7.0

REFERENCES

Camp Dresser and McKee (CDM). 1987. *Draft Phase 1a Remedial Investigation for the Iron Horse site, Billerica, MA*. Report prepared for the U.S. Environmental Protection Agency. July 1987.

Camp Dresser and McKee (CDM). 1991. *Final Draft Phase 1c Feasibility Study for the Shaffer Landfill, Iron Horse Park Site, Billerica, MA*. Report prepared for the U.S. Environmental Protection Agency. November 1991.

Castle, R.O. 1959. Surficial geology of the Wilmington Quadrangle, Massachusetts. U.S. Geological Survey geologic quadrangle map GQ-122.

Clarke, M.S. 1974. *The Old Middlesex Canal*. Melrose, MA: The Hilltop Press.

Day, K.E., B.J. Dutka, K.K. Kwan, N. Batista, T.B. Reynoldson, and J.L. Metcalfe-Smith. 1995. *Correlations Between Solid-Phase Microbial Screening Assays, Whole-Sediment Toxicity Tests with Macroinvertebrates and In-Situ Benthic Community Structure*. J. Great Lakes Res. 21(2):192-206.

Doherty, F.G. 2001. *A Review of the Microtox 7 Toxicity Test System for Assessing the Toxicity of Sediments and Soils*. Water Qual. Res. J. Canada 36:475-518.

Giesy, J. P., R.L. Graney, J.L. Newsted, C.J. Rosiu, A. Benda, R.G. Kreis, Jr, and F. J. Horvath. 1988. *Toxicity of the Detroit River Sediment Interstitial Water to the Bacterium Photobacterium phosphoreum*. J. Great Lakes Res. 14(4):502-513.

Giesy, J. P. and R. Hoke. 1989. *Freshwater sediment toxicity bioassessments: Rationale for species selection and test design*. J. Great Lakes Res. 15(4):539-569.

Goldberg, Zoino, and Associates (GZA). 1987. *PCB Investigation Report, Manville Corporation, North Billerica, MA*. Report prepared for Manville Corporation. March 1987.

MacDonald, D.D., C.G. Ingersoll and T.A. Berger. 2000. *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems*. Arch. Environ. Contam. Toxicol. 39:20-31.

Metcalf and Eddy, Inc. (M&E). 1994. *PCB Contamination Evaluation Report - Iron Horse Park Superfund Site, 3rd. Operable Unit, North Billerica, MA*. Report prepared for the U.S. Environmental Protection Agency. February 1994.

Metcalf and Eddy, Inc. (M&E). 1995. *Ecological Characterization For Remedial Investigation - Iron Horse Park Superfund Site, 3rd Operable Unit, North Billerica, MA*. Report prepared for the U.S. Environmental Protection Agency. April 1995.

Metcalf and Eddy, Inc. (M&E). 1996. Personal communication of J. Young, M&E, with J. Morris, Director of Public Health, Billerica Health Department. March 21, 1996.

Metcalf and Eddy, Inc. (M&E). 1997. *Remedial Investigation Final Report - Iron Horse Park Superfund Site, 3rd Operable Unit, North Billerica, MA*. Report prepared for the U.S. Environmental Protection Agency. September 1997.

Metcalf & Eddy (M&E). 2004. *Feasibility Study Final Report, Iron Horse Park Superfund Site, 3rd Operable Unit, North Billerica, Massachusetts*. June 2004.

Metcalf & Eddy (M&E). 2005. *Data Evaluation Report, Iron Horse Park Superfund Site, Operable Unit 4, North Billerica, Massachusetts*. March 2005.

Metcalf & Eddy (M&E). 2006a. *Ecological Risk Assessment / Wetlands Remedial Investigation Addendum (ERA/WRIA)*, Iron Horse Park Superfund Site, Operable Unit 4, North Billerica, Massachusetts. September 2006.

Metcalf & Eddy (M&E). 2006b. *Groundwater Data Evaluation Report, Iron Horse Park Superfund Site, Operable Unit 4, North Billerica, Massachusetts*. September 2006.

Metcalf & Eddy (M&E). 2008a. *Supplemental Human Health Risk Assessment, Iron Horse Park Superfund Site, Operable Unit 4, North Billerica, Massachusetts*. February 2008.

Metcalf & Eddy (M&E). 2008b. *Supplemental Groundwater Data Evaluation Report, Iron Horse Park Superfund Site, Operable Unit 4, North Billerica, Massachusetts*. November 2008.

Owenby, J.R., and D.S. Ezell. 1992. Monthly Station Normals of Temperature, Precipitation, Heating and Cooling Degree Days, 1961-1990, Massachusetts. *Climatology of the United States*, no. 81. Department of Commerce, National Oceanic and Atmospheric Administration, National Climatic Data Center, Asheville, NC. January 1992.

Plafkin, J.L, M.T. Barbour, K.D. Porter, S.K. Gross and R.M. Hughes. 1989. Rapid Bioassessment Protocols for Use in Strams and Rivers: Benthic Macroinvertebrates and Fish. USEPA Office of Water Regulations and Standards, Washington, DC. EPA/444/4-89-001.

Suter, G.W., II. and C.L. Tsao. 1996. Toxicological benchmarks for screening potential contaminants of concern for effects on aquatic biota, 1996 revision. Environmental Sciences Division. Oak Ridge National Laboratory. ES/ER/TM-96/R2.

U.S. Environmental Protection Agency (USEPA). 1986a. Quality criteria for water. Office of Water Regulations and Standards. Washington, D.C. EPA 440/5-86-001. May 1986.

U.S. Environmental Protection Agency (USEPA). 1986b. Update #1 to quality criteria for water. Office of Water Regulations and Standards. Washington, D.C.

U.S. Environmental Protection Agency (USEPA). 1987. Update #2 to quality criteria for water. Office of Water Regulations and Standards. Washington, D.C.

U.S. Environmental Protection Agency (USEPA). 1992a. Water quality standards: Establishment of numeric criteria for priority toxic pollutants; State's compliance. Fed. Regist. 57:50848-60919.

U.S. Environmental Protection Agency (USEPA). 1996. Eco update, Ecotox Thresholds. Office of Solid Waste and Emergency Response. EPA 540/F-95/038. January 1996.

U.S. Environmental Protection Agency (USEPA). 1998. National recommended water quality criteria. Federal Register. December 10, 1998.

U.S. Environmental Protection Agency (USEPA). 2002. Nationally recommended water quality criteria: 2002. Office of Water, Science and Technology. EPA 822-R-02-047.

U.S. Environmental Protection Agency (U.S. EPA). 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final*, Office of Solid Waste and Emergency Response, Washington, D.C., EPA/540/G-89/004, OSWER Directive 9355.3-01, October.

U.S. Environmental Protection Agency (U.S. EPA). 1990. National Oil and Hazardous Substances Pollution Contingency Plan (National Contingency Plan; NCP). Code of Federal Regulations, Title 40, Part 300, Federal Register, Volume 55, Number 46, pp. 8666 et seq. March 9.

U.S. Environmental Protection Agency (U.S. EPA). 2005. *Contaminated Sediment Remediation Guidance for Hazardous Waste Sites*, Office of Solid Waste and Emergency Response, Washington, D.C., EPA-540-R-05-012, OSWER 9355.0-85, December.

TABLES

TABLE ES-1. ABBREVIATED COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

Alternative	Medium: Threshold Criteria / Cost	Groundwater					
		Protection of Human Health	Protection of Environment	ARARs	Capital Cost (\$million)	O&M Cost (\$million)	Total Cost (\$million)
GW-1: No Action		<input type="checkbox"/>	N/A	<input type="checkbox"/>	\$0.00	\$0.00	\$0.00
GW-2: Limited Action		<input checked="" type="checkbox"/>	N/A	<input checked="" type="checkbox"/>	\$0.22	\$1.01	\$1.28

Alternative	Medium: Threshold Criteria / Cost	Sediment					
		Protection of Human Health	Protection of Environment	ARARs	Capital Cost (\$million)	O&M Cost (\$million)	Total Cost (\$million)
SD-1: No Action		N/A	<input type="checkbox"/>	<input type="checkbox"/>	\$0.00	\$0.00	\$0.00
SD-4: Source Control – Excavation (B&M Pond) with Disposal		N/A	■	■	\$3.42	\$0.63	\$4.07
SD-6: Source Control – Excavation (B&M Pond and Unnamed Brook) with Disposal		N/A	■	■	\$5.41	\$0.00	\$5.41

Notes

Total Costs include Periodic Costs.

Protection of Human Health/Environment:

☐ - No Protection, ☒ - Partially Protective, ☒ - Protective

N/A - Not applicable: Risk limits not exceeded for this media and AOC

ARARs:

☐ - Does Not Meet, ☒ - May Not Meet/Partially Meets, ☒ - Meets

TABLE 1-1. CHRONOLOGY OF SITE HISTORY

Year	Activities within the Site Boundaries
1911	B&M Railroad purchased 553 acres of land that now makes up the Iron Horse Park Site.
1913	B&M Railroad began operations at the site.
1924	B&M Railroad began operating a combined sewage and drainage system for the Iron Horse Industrial Park.
1938	Oil and sludge recycling activities began on B&M property later owned by the Omega Trust and currently owned by Penn Culvert.
1944	B&M Corporation sold approximately 70 acres of land to Johns-Manville Products Corporation, which manufactured structural insulating board. Two unlined lagoons, located on the newly purchased land, were used to dispose of asbestos sludge waste. In addition, approximately 15 acres of land were leased from B&M for use as a landfill for asbestos waste.
1961	Johns-Manville sold the western portion of its land to General Latex and Chemical Corporation.
1962	B&M Railroad sold approximately 1.2 acres of land and an existing building to Wood Fabricators, Inc.
1966	B&M Corporation sold an additional 0.67 acres of land to Wood Fabricators, Inc.
1966	B&M Corporation sold approximately 106 acres of land to Phillip Shaffer as Trustee of Gray Pond Realty Trust. Prior to 1966, this land was used for open burning.
1968	Billerica Board of Health ordered that open burning practices cease on the land owned by Phillip Shaffer. The land was then used as a landfill, accepting both commercial and residential waste materials. This area is known as the Shaffer or Pond Street Landfill.
1969	Aerial photographs indicate significant expansion of existing landfill areas located in the eastern portion of Iron Horse Park. These areas include B&M land being used by Johns-Manville for disposal of asbestos waste, the B&M landfill north of the canal, and the Shaffer Landfill.
1973	Omega Trust sold the oil and sludge recycling area to Penn Culvert Company.
1976	Aerial photographs indicate that the expansion of the existing landfills has slowed or even halted. Vegetation has returned to parts of each landfill.
1976	B&M Corporation sold approximately 150 acres of primarily developed land to the MBTA to operate passenger rail service, including land along the northern portion of the Shaffer landfill.
1979	Aerial photographs indicate that the old B&M oil & sludge recycling area has been cleared, leveled, and filled. The area is currently a partially paved lot used as a storage area.
1984	Iron Horse Park Site was placed on the National Priorities List as a result of MassDEP investigations and a site investigation report.
1984	A lawsuit was filed against Phillip Shaffer by the MassDEP for environmental violations.

TABLE 1-1. CHRONOLOGY OF SITE HISTORY

Year	Activities within the Site Boundaries
1984	The Johns-Manville asbestos landfill was capped during an immediate removal action under CERCLA performed by the EPA.
1986	In compliance with a state court order, the Shaffer Landfill ceased operations in April 1986.
1988	B&M wastewater lagoons (OU-1) Record of Decision (ROD) signed on September 15, 1988.
1991	Shaffer Landfill (OU-2) ROD signed on June 27, 1991.
1997-2003	In October 1997, EPA issued an Explanation of Significant Differences (ESD) which changed the chosen remedy from the OU-1 portion of the site from bio-remediation to excavation and removal of contaminated soils and sludge for asphalt batching. Asphalt batching involves blending the contaminated material with asphaltic material at an asphalt batching plant to produce a stabilized mixture in which the contaminants are immobilized. This material is suitable for use as a base for paving. In October and November 1997, approximately 10,000 cubic yards of contaminated material were removed by the owner to an asphalt batching plant for treatment. In the fall of 2000, closure sampling was conducted to confirm that all material requiring treatment had been removed. Material that exceeds the cleanup criteria was excavated and removed in the late summer of 2002. A completion report documenting the completion of cleanup activities at the Lagoon Areas was submitted by the PRPs in September 2003.
1991-2003	The Shaffer Landfill has two lobes and occupies approximately 60 acres. In 1991, the EPA completed an investigation of the Shaffer Landfill area that evaluated the current cover and considered other capping options. Cleanup methods selected included reconstruction of the landfill cap and collection and off-site treatment and disposal of leachate. In August 2000, a settlement was reached between EPA, MassDEP and a group of potentially responsible parties to undertake the cleanup of Shaffer Landfill. Construction of the landfill cap began in the spring of 2001 and was completed during the summer of 2003. The PRP group which performed the construction, submitted a final construction report in September 2003, documenting the construction activities and demonstrating compliance with the requirements of the project. The Operation and Maintenance phase of the project began in the fall of 2003. This phase entails maintenance of the landfill cap and associated features of the remedy, as well as monitoring of groundwater, burning of landfill gas (via the on-site flare) and collection and disposal of leachate.

TABLE 1-1. CHRONOLOGY OF SITE HISTORY

Year	Activities within the Site Boundaries
1993-2005	Extensive sampling was conducted during 1993 to evaluate the levels, extent, potential sources, and possible means of migration of contamination in soil, groundwater, sediment, and surface water and associated with a number of source areas around Iron Horse Park. Additional investigations including a risk assessment began in 1994. A remedial Investigation (RI) was completed in the fall of 1997. A Feasibility Study (FS) was completed in May 2004 to evaluate potential alternatives for the remediation of this area. In addition, a Proposed Plan recommending a series of cleanup alternatives, was completed in May 2004. The Proposed Plan was mailed to interested parties on May 26, 2004. EPA held an informational meeting regarding the Proposed Plan on June 16, 2004 at Town Hall in Billerica. The ROD selecting the remedies for the affected media was signed on September 30, 2004. This ROD, which addressed the source areas only, chose capping in-place for the different source areas.
September 2003	In September 2003, EPA completed the 2nd Five-Year Review for Iron Horse Park. The purpose of five-year reviews is to periodically (at least every 5 years) revisit sites that either have waste left in place at the end of a cleanup, or those sites where cleanups have not yet been completed, and to determine whether the remedy chosen in the ROD, remains protective. As a ROD has been signed choosing a remedy for Shaffer Landfill and the Lagoon Areas, the 2nd Five-Year Review primarily focused on evaluating the protectiveness of these remedies. The Five-Year Review concluded that the remedies for these areas remain protective.
2004	Additional sampling of surface water, sediment, and fish was performed to further evaluate risk to environmental receptors.
2005-2006	An additional groundwater investigation was performed to provide an updated status of groundwater contaminants at the site.
2008	In September 2008, EPA completed the 3 rd Five-year Review for Iron Horse Park. Similar to the previous review, this report concluded that the remedies for Shaffer Landfill and the Lagoon Areas remain protective. The source area remedy had not yet been implemented, but was still expected to be protective upon implementation.
2010	Source Areas, Operable Unit 3 - Cap construction underway for one source area; design underway at remaining six areas.

**TABLE 1-2
SUMMARY OF RISK ENDPOINTS FOR AQUATIC LIFE
IRON HORSE PARK SUPERFUND SITE - OU-4**

Location	Sample ID	<i>C. dubia</i> ⁽¹⁾		<i>P. promelas</i> ⁽¹⁾		Fish Tissue ⁽²⁾
		survival	reproduction	survival	growth	
Richardson Pond	SW-RP-01	-	-	-	-	No HQs > 1
West Middlesex Canal	SW-MC-01	-	-	57.5%*	-(3)	No HQs > 1
B&M Pond	SW-BM-01	-	-	-	-	No HQs > 1 ⁽⁴⁾
Content Brook	SW-CB-01	-	-	-	-(3)	No HQs > 1

⁽¹⁾ Endpoints from toxicity tests are based on statistically significant difference (p<0.05) from reference;

"-" indicates no significant difference from reference sample.

"**" indicates statistical decrease from reference

⁽²⁾ HQ - Hazard quotients based on the ratio of maximum measured tissue concentration to tissue residue effects benchmark
(see Tables 6-5 to 6-8 of ERA/WRIA; M&E, 2006a)

⁽³⁾ Although the statistical comparisons indicated a statistical difference from reference, there was no significant difference from the laboratory control. Due to the small reduction in growth and the differences in the laboratory controls, these results are not considered a biologically significant reduction in the endpoint.

⁽⁴⁾ No HQs > 1 for any COPCs, however, elevated tissue concentrations of PAHs observed in B&M pond

**Table 1-3. Summary of 2004 Surface Water Analytical Results
Iron Horse Park Superfund Site - OU-4**

M&E Sample ID Date Sampled Comments	SW-RP-01 09/22/04	SW-RP-02 09/22/04	SW-RP-03 09/22/04	SW-MC-01 09/23/04 FD of SW-MC-21	SW-MC-21 09/23/04 FD of SW-MC-01	SW-MC-02 09/23/04	SW-MC-03 09/23/04
<u>Dissolved Metals (ug/L)</u>							
Aluminum	15.0 U	15.0 U	15.0 U	23.2 J	21.4 J	21.5 J	20.8 J
Arsenic	2.8 J	2.8 J	2.7 J	1.3 J	1.2 J	1.3 J	1.3 J
Barium	25.5	25.1	25.2	26.6	26.6	26.7	26.4
Calcium	13400	13300	13300	12000	12000	12000	12000
Chromium	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U
Cobalt	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Copper	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Lead	0.19 J	0.16 J	0.13 J	0.41	0.31	0.39	0.34
Magnesium	3190	3170	3150	2040	2060	2050	2040
Manganese	216	214	214	135	133	132	131
Silver	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
Vanadium	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U
Zinc	5.0 U	5.0 U	5.0 U	9.5 J	5.0 U	5.0 U	5.0 U
<u>Total Metals (ug/L)</u>							
Aluminum	15.0	17.5 J	16.0 J	31.1	40.8	39.9	40.0
Arsenic	3.4 J	3.4 J	3.3 J	1.4 J	1.4 J	1.5 J	1.5 J
Barium	24.9	24.7	24.7	25.9	26.2	26.3	26.5
Calcium	13300	13200	13100	11800	11900	11900	11900
Chromium	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U
Cobalt	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Copper	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Lead	0.25	0.27	0.25	0.66	0.69	0.75	0.80
Magnesium	3190	3160	3150	2040	2060	2060	2060
Manganese	219	218	216	140	146	154	164
Silver	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
Vanadium	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U
Zinc	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
<u>Alkalinity (mg/L)</u>							
Alkalinity, Total as CaCO ₃	32.6	33.4	38.6	30.4	30.9	33.4	31.5

**Table 1-3. Summary of 2004 Surface Water Analytical Results
Iron Horse Park Superfund Site - OU-4**

M&E Sample ID Date Sampled Comments	SW-CB-01 09/23/04	SW-CB-02 09/23/04	SW-CB-03 09/23/04	SW-BM-01 09/21/04	SW-BM-02 09/21/04	SW-BM-03 09/21/04	SW-RF-01 09/24/04	SW-RF-02 09/24/04	SW-RF-03 09/24/04
<u>Dissolved Metals (ug/L)</u>									
Aluminum	49.6	50.2	54.2	26.4 J	27.0 J	28.1 J	34.3	36.9	38.4
Arsenic	1.7 J	1.7 J	1.8 J	2.3 J	2.2 J	2.1 J	1.0 J	1.0 J	1.1 J
Barium	39.1	39.1	39.4	24.1	24.7	24.4	18.1	18.3	18.3
Calcium	13200	13200	13200	10300	10400	10300	8940	8970	8950
Chromium	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U
Cobalt	1.0 U	1.0 U	1.1 J	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Copper	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Lead	0.34	0.37	0.45	0.83	0.70	0.61	0.41	0.31	0.32
Magnesium	2500	2490	2500	1740	1760	1740	1660	1670	1670
Manganese	263	263	274	128	127	112	177	175	173
Silver	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
Vanadium	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U
Zinc	5.5 J	6.0 J	12.6	6.2 J	5.0 U	5.0 U	8.2 J	5.0 U	5.0 U
<u>Total Metals (ug/L)</u>									
Aluminum	73.2	152.0	71.2	52.2	52.0	51.1	42.5	37.0	36.2
Arsenic	2.5 J	3.1 J	2.4 J	2.6 J	2.5 J	2.6 J	1.1 J	1.1 J	1.1 J
Barium	38.9	41.2	38.7	24.3	24.2	23.9	18.8	18.2	18.1
Calcium	13100	13300	13100	10300	10200	10200	8970	8960	8960
Chromium	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U
Cobalt	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U	1.0 U
Copper	1.0 U	1.0 U	1.0 U	1.1 J	1.1 J	1.4 J	1.0 U	1.0 U	1.0 U
Lead	1.0	1.7	0.96	1.6	1.6	1.6	0.58	0.44	0.41
Magnesium	2500	2530	2500	1760	1750	1730	1670	1680	1680
Manganese	282	330	280	136	137	123	253	230	200
Silver	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
Vanadium	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U
Zinc	5.0 U	6.7 J	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U	5.0 U
<u>Alkalinity (mg/L)</u>									
Alkalinity, Total as CaCO ₃	35.5	36.7	36.2	27.2	23.7	27.7	20.7	21.8	13.9

EB - As a qualifier for soil/sediment samples: Analyte is also detected in the equipment blank
FD - Field Duplicate
J - The concentration is an estimated quantity
mg/Kg - milligrams per Kilogram
mg/L - milligrams per Liter
PAL - Project Action Limit
R - The data are rejected as unusable
U - Analyte was analyzed for but not detected
ug/Kg - micrograms per Kilogram
ug/L - micrograms per Liter
UJ - The sample quantitation limit is an estimated quantity

**TABLE 1-4
CONTAMINANT SCREENING FOR SURFACE WATER
IRON HORSE PARK SUPERFUND SITE - OU-4**

Chemical	Frequency of Detection ⁽¹⁾	Maximum Detected Concentration (ug/L)	Location of Maximum Detected Concentration	Maximum Reference Sample Concentration	Unadjusted Criterion (ug/L)	Screening Criterion ⁽²⁾ (ug/L)	Type	Number of Exceedances	Reason for Exclusion ⁽⁶⁾
<u>Inorganics (Total)</u>									
Aluminum	12/12	152	SW-CB-02	42.5	87	87	NRWQC	1	
Arsenic	12/12	3.4	SW-RP-01 and SW-RP-02	1.1					
Barium	12/12	41.2	SW-CB-02	18.8					
Calcium	12/12	13,300	SW-RP-01 and SW-CB-02	8,970					
Chromium	0/12	ND	ND	ND					
Cobalt	0/12	ND	ND	ND					
Copper	3/12	1.4	SW-BM-03	ND					
Lead	12/12	1.7	SW-CB-02	0.58					
Magnesium	12/12	3,190	SW-RP-01	1,680					
Manganese	12/12	330	SW-CB-02	253					
Silver	0/12	ND	ND	ND					
Vanadium	0/12	ND	ND	ND					
Zinc	1/12	6.7	SW-CB-02	ND					
<u>Inorganics (Dissolved)</u>									
Aluminum	9/12	54.2	SW-CB-03	38.4					
Arsenic	12/12	2.8	SW-RP-01 and SW-RP-02	1.1	150	150	NRWQC ⁽³⁾	0	BSV
Barium	12/12	39.4	SW-CB-03	18.3	4	4	Tier II	12	
Calcium	12/12	13,400	SW-RP-01	8,970	NA	NA	NA	0	NUT
Chromium	0/12	ND	ND	ND	109.5	35	NRWQC ^{(4),(5)}	0	DF
Cobalt	1/12	1.1	SW-CB-03	ND	3	3	Tier II	0	BSV
Copper	0/12	ND	ND	ND	13.5	4.1	NRWQC ⁽⁴⁾	0	DF
Lead	12/12	0.83	SW-BM-01	0.41	4.2	0.9	NRWQC ⁽⁴⁾	0	BSV
Magnesium	12/12	3,190	SW-RP-01	1,670	NA	NA	NA	0	NUT
Manganese	12/12	274	SW-CB-03	177	80	80	Tier II	12	
Silver	0/12	ND	ND	ND	0.36	0.36	SCV	0	DF
Vanadium	0/12	ND	ND	ND	19	19	Tier II	0	DF
Zinc	5/12	12.6	SW-CB-03	8.2	177	55	NRWQC ⁽⁴⁾	0	BSV

⁽¹⁾ Frequency of detection among the 12 study area samples.

⁽²⁾ The NRWQC for aluminum is based on total concentration. For other metals the dissolved metals concentrations are compared to screening benchmarks because dissolved concentrations correspond to the NRWQC or TIER II value and represent bioavailable form of the metal.

⁽³⁾ Value reported for arsenic(III).

⁽⁴⁾ Metals criteria adjusted for hardness (40.2 mg/L as CaCO₃) using equations provided in USEPA, 2002.

⁽⁵⁾ Value reported for chromium(III). It is assumed that chromium in surface water is present in reduced form.

⁽⁶⁾ Reasons for exclusion were that maximum detected level was below the screening value (BSV), the frequency of detection was less than or equal to 5% (DF), and/or the analyte was a major nutrient.

COPC - Chemical of Potential Concern

ND - Not Detected

NRWQC - Freshwater Chronic National Recommended Water Quality Criterion (USEPA 1986a,b; 1987; 1992a, 1998, 2002).

SCV - Secondary Chronic Value as presented in Suter and Tsao (1996).

Tier II - Ecotox Thresholds Great Lakes Water Quality Initiative Tier II Methodology (USEPA, 1996).

NA - Screening criterion Not Available

BSV - Below Screening Value

DF - Detection Frequency

NUT - Nutrient

**TABLE 1-5. NOTABLE DETECTIONS AND OBSERVATIONS OF WINTER 2005-2006
GROUNDWATER MONITORING ROUND**

Well ID	Original Selection Rationale (based on historical monitoring data)	Notable Detections and Observations of Winter 2005-2006 Monitoring Round
Existing Monitoring Wells – “OW” Series		
OW-01	TCE detected at the MCL/PRG (5 µg/L)	TCE now below PRG (1.5 µg/L); detections of 1,1-DCA (1.4 µg/L) and 1,2-DCA (0.74 µg/L); previously detected at 2 µg/L
OW-02	Mn detected above the PRG	Mn detected at the same magnitude; As above PRG
OW-07	The second highest PCB concentration detected, as well as TCE above the PRG	PCBs now non-detect (ND); TCE reduced from 21 µg/L to 4.6 µg/L; 1,1-DCA (0.34 µg/L); chloromethane (1.6 µg/L); t-1,2-DCE (0.58 µg/L); Mn detected above PRG at similar magnitude to historical results
OW-08	Benzene detected, as well as pesticides	Benzene still detected above PRG, but at 59 µg/L rather than above 300 µg/L; 1,1,1-TCA, 1,1-DCA, and chlorobenzene were previously not detected and are now present at 22, 38, and 46 µg/L, respectively; other miscellaneous VOCs, including BTEX compounds, detected at low concentrations; phenol was the only SVOC detected (5.7 µg/L); pesticides were ND; metals detected at similar magnitude to historical results (Mn and As above PRG)
OW-09	The highest concentration of PCBs detected here	VOCs previously detected (1,1-DCA, 1,2-dichlorobenzene, and 1,2-DCA) decreased in concentration; a few new VOCs detected all at less than 5 µg/L, with most below 1 µg/L; one pesticide (alpha-chlordane) detected (0.0051 µg/L); PCBs were ND; high Mn (22600 µg/L)
OW-10	Mn detected above the PRG	Miscellaneous VOCs and SVOCs detected – none above PRGs; metals at similar magnitude to historical results
OW-12	1,1,2,2-Tetrachloroethane detected above the PRG	1,1,2,2-Tetrachloroethane now ND; miscellaneous VOCs, including BTEX compounds, detected at low concentrations (< 2 µg/L); As above PRG; Mn now below PRG
OW-20	Pesticides detected and Mn detected above the PRG	Miscellaneous VOCs detected; TCE and PCE above PRGs (7 and 39 µg/L, respectively); pesticides now ND; As and Mn above PRGs
OW-25	Tl and Mn detected above the PRGs	Miscellaneous VOCs detected; TCE and PCE just below PRGs (3.2 and 4.4 µg/L, respectively); Mn above PRG; Tl was ND, but the DL was elevated (5 µg/L) above the PRG of 2 µg/L
OW-26	Pesticides detected	Pesticides now ND; As above PRG
OW-35	Pesticides near the Contaminated Soils Area detected here	No organics detected; Mn at 327 µg/L – previously 306 µg/L (similar to historical)
OW-37	Mn detected above the PRG	Miscellaneous organics detected; Mn similar to historical results
OW-38	A downgradient location from the Oil/Sludge Recycling Area (which had detections of 1,1,1-TCA); Mn detected above the PRG	1,4-Dioxane was ND; VOC detections were higher than most other locations – PCE above PRG (14 µg/L), carbon tetrachloride at 37 µg/L; Mn similar to historical results
OW-49	Close to off-site; downgradient of B&M Railroad Landfill	1,2-DCA at PRG (5 µg/L; was previously above PRG); TCE still above PRG (7.8 µg/L), but a lot lower than historical values (22-25 µg/L); Mn still above PRG (516 µg/L), but now half of historical results

**TABLE 1-5. NOTABLE DETECTIONS AND OBSERVATIONS OF WINTER 2005-2006
GROUNDWATER MONITORING ROUND**

Well ID	Original Selection Rationale (based on historical monitoring data)	Notable Detections and Observations of Winter 2005-2006 Monitoring Round
OW-50	Close to off-site; downgradient of B&M Railroad Landfill; check for 1,4-dioxane in a downgradient location	1,4-Dioxane detected (0.59 µg/L) below state MCL; Mn still moderate (1350 µg/L)
OW-51	Close to off-site; downgradient of B&M Railroad Landfill	(no historical results) – As and Mn above PRGs
Existing Monitoring Wells – “MW” Series		
MW-202B	Check to see if contaminants migrated out of Oil/Sludge Recycling Area	No notable detections
MW-202D	Check to see if contaminants migrated out of Oil/Sludge Recycling Area	No notable detections
MW-202S	Check to see if contaminants migrated out of Oil/Sludge Recycling Area; check surficial aquifer for pesticide detections	High detection of carbon tetrachloride (120 µg/L); miscellaneous VOCs and SVOCs detected; pesticides were ND; As above PRG
MW-203B	Check to see if contaminants migrated out of Oil/Sludge Recycling Area	No notable detections
MW-203D	1,1,1-TCA detected	1,1,1-TCA still detected, but lower (0.16 µg/L); no PRG exceedances; 1,4-dioxane at 2.9 µg/L
MW-203S	1,1,1-TCA detected in MW-203D; check surficial aquifer in the area downgradient of the Oil/Sludge Recycling Area	Mn above PRG; 1,4-dioxane was ND
MW-204S	1,1,2,2-Tetrachloroethane and Mn detected above the PRGs	Acenaphthene only organic detected; Mn detected well above the PRG (22400 µg/L)
MW-205S	Check the surficial aquifer in the Locomotive Shop Disposal Areas	Acenaphthene and phenanthrene only organics detected; Mn above PRG
MW-206D	Check the deep aquifer in the Locomotive Shop Disposal Areas	1,2-Dichloropropane and MTBE only organics detected; no PRG exceedances
MW-206S	Check the surficial aquifer in the Locomotive Shop Disposal Areas	MTBE only organic detected; Mn above PRG
MW-207B	Location upgradient of Asbestos Landfill; historical detections of 1,1,1-TCA and 1,2-DCA	Miscellaneous VOCs detected, including TCE and PCE above PRGs; 1,1,1-TCA detected at 2.3 µg/L, which is just below the historical detection of 3 µg/L; 1,2-DCA detected at 2.6 µg/L which is less than half of historical results; Mn above PRG; 1,4-dioxane at 1.3 µg/L
MW-208B	BEHP detected above the PRG	BEHP now below PRG; Mn now below PRG
MW-208D	BEHP detected above the PRG	BEHP now below PRG; Mn above PRG
MW-208S	As and Mn detected above the PRGs	As and Mn detected at magnitudes similar to historical results
MW-209B	1,2-DCA and Mn detected above PRGs	Both 1,2-DCA and Mn still above PRGs, with 1,2-DCA approximately half of historical results
MW-210S	Metal concentrations higher than most other site locations	Similar to historical results; As and Mn above PRGs
MW-211D	Metal concentrations higher than most other site locations	Similar to historical results; As and Mn above PRGs
MW-211S	Pesticides, Mn, and As concentrations higher than most other site locations	No organics detected; As and Mn reduced in magnitude compared to historical results
MW-212B	Mn detected above the PRG	As and Mn above PRGs
MW-212D	1,1,2,2-Tetrachloroethane and manganese detected above the PRGs	1,1,2,2-Tetrachloroethane now ND; As and Mn above PRGs

**TABLE 1-5. NOTABLE DETECTIONS AND OBSERVATIONS OF WINTER 2005-2006
GROUNDWATER MONITORING ROUND**

Well ID	Original Selection Rationale (based on historical monitoring data)	Notable Detections and Observations of Winter 2005-2006 Monitoring Round
MW-213B	Multiple chlorinated VOCs detected above PRGs	1,1-DCE and 1,2-DCA now below PRGs; TCE still above PRG (16 µg/L), but trending downwards; metals below PRGs
MW-213D	Chlorinated VOCs and Mn detected above PRGs	1,1-DCE now ND; TCE now below PRG (4.8 µg/L) – down significantly; Mn now below PRG
MW-213S	PCBs and pesticides detected here	A few pesticides detected; PCBs now ND; Mn above PRG
MW-214S	The highest site PCB concentrations were detected here, along with exceedances of PRGs by pesticides, Mn, and As	Pesticides/PCBs now ND; As and Mn still above PRGs
MW-215B	BEHP detected above the PRG	BEHP now ND
Existing Barcad Well – “MW” Series		
MW-01	Check the most downgradient wells	(no historical results) – Two PAHs detected at 0.012 µg/L, no PRG exceedances
MW-01A	Check the most downgradient wells; sample one deep overburden well for 1,4-dioxane	No PRG exceedances; 1,4-dioxane was ND
MW-01B	Check the most downgradient wells	(no historical results); similar to MW-01; two PAHs detected; no PRG exceedances;
MW-01C	Check the most downgradient wells; sample the shallow overburden well for 1,4-dioxane	No organics detected (including 1,4-dioxane); no PRG exceedances
Wells Installed Winter 2005-2006		
MW-301S	Check the surficial aquifer in the Oil/Sludge Recycling Area for PCBs/pesticides; 1,1,1-TCA detected in the historical MW-201S location	MTBE detected (3.4 µg/L); As and Mn above PRGs; 1,4-dioxane was ND
MW-301D	1,1,1-TCA detected in the historical MW-201S location	MTBE detected (0.21 µg/L); toluene detected (0.13 µg/L)
MW-301B	Replace destroyed wells upgradient of the Oil/Sludge Recycling Area	Toluene detected at 0.2 µg/L
MW-302S	Check the surficial aquifer in the area downgradient of the Oil/Sludge Recycling Area; screen at the water table to look for LNAPL	No organics detected; no notable metal detections
MW-303S	LNAPL was historically found in destroyed piezometer P-12. Check the surficial aquifer in this area and screen at the water table to look for LNAPL; likely location for LNAPL sample	Carbon tetrachloride detected (0.39 µg/L); As and Mn above PRGs; LNAPL not detected
MW-304S	Fill a data gap at the Contaminated Soils Area	PCE detected (0.085 µg/L); delta-BHC detected (0.0054 µg/L)
MW-304D	Fill a data gap at the Contaminated Soils Area; sample for 1,4-dioxane in the deep overburden flow zone	Bromochloromethane, PCE, and toluene detected (0.057, 0.34, and 0.46 µg/L, respectively); 1,4-dioxane was ND
MW-304B	Fill a data gap at the Contaminated Soils Area	1,1-DCA (0.47 µg/L) and bromochloromethane (0.27 µg/L) detected; bis(2-chloroethyl)ether, butylbenzylphthalate, and naphthalene detected at less than 0.2 µg/L

**TABLE 1-5. NOTABLE DETECTIONS AND OBSERVATIONS OF WINTER 2005-2006
GROUNDWATER MONITORING ROUND**

Well ID	Original Selection Rationale (based on historical monitoring data)	Notable Detections and Observations of Winter 2005-2006 Monitoring Round
MW-305S	Fill a data gap upgradient of the Asbestos Landfill; 1,1,1-TCA was previously detected in MW-207B	Miscellaneous VOCs and SVOCs detected – all less than 2 µg/L; 4,4'-DDT and dieldrin detected; Mn above PRG; 1,4-dioxane was ND
MW-305D	Fill a data gap upgradient of the Asbestos Landfill; 1,1,1-TCA was previously detected in MW-207B	Miscellaneous VOCs and SVOCs detected – all less than 5 µg/L; 1,4-dioxane at 1.7 µg/L; 1,2-DCA close to PRG (4.8 µg/L)
MW-306S	Fill a data gap upgradient of the Asbestos Landfill	Miscellaneous VOCs and SVOCs detected, including phenols, phthalates, and PAHs – none above 1 µg/L
MW-307S	Fill a data gap at the Asbestos Landfill	Benzene detected above PRG (6.6 µg/L); many VOCs detected, including vinyl chloride (0.66 µg/L); miscellaneous SVOCs detected – all below 1.5 µg/L; Mn above PRG
MW-307D	Fill a data gap at the Asbestos Landfill	Many VOCs detected; 1,2-DCA above PRG (11 µg/L)
MW-307B	Fill a data gap at the Asbestos Landfill	Many VOCs detected; 1,2-DCA above PRG (23 µg/L); As above PRG
MW-308B	Check the bedrock aquifer below the Asbestos Landfill	Many VOCs detected; 1,2-DCA above PRG (8.5 µg/L); TCE well above PRG (75 µg/L); vinyl chloride detected (0.74 µg/L); 1,4-dioxane detected (2 µg/L)
Existing Piezometers – “PZ” Series		
PZ-115	Sample LNAPL	LNAPL determined to be No. 6 Fuel Oil

Notes

1,1,1-TCA – 1,1,1-Trichloroethane

1,1-DCE – 1,1-Dichloroethene

1,2-DCA – 1,2-Dichloroethane

As – Arsenic

BEHP – Bis(2-ethylhexyl)phthalate

LNAPL – Light non-aqueous phase liquid

MCL – Maximum Contaminant Limit

Mn – Manganese

ND – Non-detect

PAHs – Polynuclear Aromatic Hydrocarbons

PCBs – Polychlorinated Biphenyls

PCE – Tetrachloroethene

PRG – Preliminary Remediation Goal

TCE – Trichloroethene

Tl – Thallium

SVOCs – Semivolatile Organic Compounds

VOCs – Volatile Organic Compounds

TABLE 1-6
ASSESSMENT AND MEASUREMENT ENDPOINT SUMMARY FOR 1997 BERA
IRON HORSE PARK SUPERFUND SITE - OU-4

Assessment Endpoint	Indicators of Effects	Measurement Endpoint
<i>FOR TERRESTRIAL HABITATS</i>		
Evidence of significant reduction in soil invertebrate populations.	Surface soil contaminant concentrations exceed toxicity benchmarks for earthworms.	Comparison of average exposure Hazard Quotient (HQ) for earthworms to toxicity reference values.
Evidence of significant reduction in small mammal populations.	Exposures exceed toxicity doses for short-tailed shrews.	Comparison of average exposure HQ for short-tailed shrews to toxicity reference values.
<i>FOR AQUATIC HABITATS</i>		
Evidence of significant reduction in aquatic populations.	Surface water and/or sediment contaminant concentrations exceed toxicity benchmarks for water column and benthic receptors.	Comparison of site Hazard Quotient (HQ) for water column and benthic receptors to toxicity reference values.
Evidence of significant reduction in aquatic populations.	Impairment of the invertebrate community relative to reference locations.	Comparison of site and reference benthic data.
Evidence of significant reduction in migratory bird population.	Exposures exceed toxicity doses for great blue heron.	Comparison of site HQ for great blue heron to toxicity reference values.

TABLE 1-7
SUMMARY OF RISK ENDPOINTS FOR BENTHIC INVERTEBRATES
IRON HORSE PARK SUPERFUND SITE - OU-4

Location	Sample ID	<i>C. tentans</i> ⁽¹⁾		<i>H. azteca</i> ⁽¹⁾	
		survival	growth ⁽²⁾	survival	growth
Unnamed Brook	SED-18	-	51%*	8%*	-
West Middlesex Canal	SED-11	-	76%*	-	-
B&M Pond	SED-05	-	73%*	-	-
Content Brook	SED-01	-	-	-	-

⁽¹⁾ Endpoints from toxicity tests are based on statistically significant difference (p<0.05) from reference;

"-" indicates no significant difference from reference sample.

"**" indicates statistical decrease from reference

⁽²⁾ Percent growth values based on comparison to growth in reference

TABLE 2-1. CHEMICAL-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE

Authority	Requirement	Status	Requirement Synopsis	Consideration in the RI/FS
Air				
Federal Regulatory Requirements	Clean Air Act (42 U.S.C., §7401 <i>et seq.</i>); Standard for inactive waste disposal sites for asbestos mills and manufacturing and fabricating operations (40 CFR Part §61.151)	Applicable	NESHAPs establishes standards for inactive waste disposal sites for asbestos mills and manufacturing and fabricating operations, for active waste disposal sites, and disposal of asbestos-containing waste.	Remedial actions which include excavation, treatment, and disposal of asbestos contaminated wastes will comply with standard.
Federal Criteria, Advisories, and Guidance	Threshold Limit Values (TLVs)	To Be Considered	These standards were issued as consensus standards for controlling air quality in work place environments.	TLVs will be used for assessing site inhalation risks for site remediation workers.
State Regulatory Requirements	Massachusetts Air Pollution Control Regulations (310 CMR 7.15)	Applicable	Provides standards for demolition and renovation of facilities or facility components that contain asbestos. Requires prevention of visible emissions of particulate matter when removing asbestos-containing materials.	The Iron Horse Park Site includes areas filled with asbestos-containing materials. These requirements are, therefore, applicable.
Groundwater				
Federal Regulatory Requirements	Resource Conservation and Recovery Act (42 U.S.C. §6901 <i>et seq.</i>); (40 CFR 264.94)	Applicable	Establishes maximum concentration limits for RCRA groundwater monitoring and response requirements. A risk-based Alternate Concentration may also be applied for. Standards for 14 toxic compounds have been adopted as part of RCRA groundwater protection standards. RCRA sets the limit for organic constituents at background levels. The groundwater protection regulations require the setting of groundwater protection standards which must be protective of public health and the environment.	During design of any groundwater interception and treatment system, these standards will be incorporated. Remedial actions will comply with either RCRA MCLs or site-specific risk-based Alternate Concentration Limits.
Federal Regulatory Requirements (continued)	Safe Drinking Water Act (42 U.S.C. §300f <i>et seq.</i>); National primary drinking water regulations (40 CFR 141)	Relevant and Appropriate	Establishes MCLs for common organic and inorganic contaminants applicable to public drinking water supplies. Used as relevant and appropriate cleanup standards for aquifers and surface water bodies that are potential drinking water sources.	Property within the site boundary is classified by the State as “Non-potential Drinking Water Source Area.” Areas adjacent to and downgradient of the site, however, are classified as Potentially Productive Aquifers and are potential drinking water source areas. Remedial actions including groundwater treatment and discharge will be designed and implemented to meet this requirement. Other alternatives will be monitored until groundwater achieves these standards. Analytes detected at the site at levels above MCLs are presented (along with the MCLs) in Table 8 of Appendix A.
	Safe Drinking Water Act (42 U.S.C. §300f <i>et seq.</i>); National primary drinking water regulations (40 CFR 141)	Relevant and Appropriate for non-zero MCLGs only; MCLGs set as zero are To Be Considered.	Establishes maximum contaminant level goals (MCLGs) for public water supplies. MCLGs are health goals for drinking water sources. These unenforceable health goals are available for a number of organic and inorganic compounds.	Groundwater adjacent to and downgradient from the site boundary is considered a potential drinking water source. Non-zero MCLGs are relevant and appropriate. MCLGs set at zero are to be considered. Remedial actions including groundwater treatment and discharge will be designed and implemented to meet this requirement. Other alternatives will achieve these standards over time.

TABLE 2-1. CHEMICAL-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE

Authority	Requirement	Status	Requirement Synopsis	Consideration in the RI/FS
Federal Criteria, Advisories, and Guidance	EPA Risk Reference Dose (RfDs)	To Be Considered	RfDs are considered to be the levels unlikely to cause significant adverse health effects associated with a threshold mechanism of action in human exposure for a lifetime.	Hazards due to noncarcinogens with EPA RfDs were used to develop target cleanup levels.
	EPA Carcinogenicity Slope Factor	To Be Considered	Slope factors are developed by EPA from health effects assessments. Carcinogenic effects present the most up-to-date information on cancer risk potency. Potency factors are developed by EPA from Health Effects Assessments of evaluation by the Carcinogenic Assessment Group.	Risks due to carcinogens as assessed with slope factors were used to develop target cleanup levels.
	Health Advisories (EPA Office of Drinking Water)	To Be Considered	Health Advisories are estimates of risk due to consumption of contaminated drinking water; they consider non-carcinogenic effects only. To be considered for contaminants in groundwater that may be used for drinking water	Health advisories will be used to evaluate the non-carcinogenic risk resulting from exposure to certain compounds (e.g., manganese).
State Regulatory Requirements	Massachusetts Ground Water Quality Standards (314 CMR §6.00)	Applicable	Establishes groundwater classifications, water quality criteria necessary to sustain the designated uses, and regulations necessary to achieve the designated uses or maintain the existing groundwater quality. When state levels are more stringent than federal levels, the state levels will be used.	Groundwater at site falls under "Class I" classification (fresh groundwater found in the saturated zone of unconsolidated deposits or consolidated rock and bedrock are designated as a potable water supply). Remedial actions including groundwater treatment and discharge will be designed to meet Class I standards. (see 314 CMR§6.06(1))
State Regulatory Requirements (continued)	Massachusetts Drinking Water Regulations (310 CMR §22.00)	Relevant and Appropriate	Establishes maximum contaminant levels that apply to public drinking water supplies. Massachusetts Maximum Contaminant Levels and Maximum Contaminant Level Goals are specified for numerous contaminants, including inorganic and organic chemicals. For the most part, the numerical criteria are identical to Federal SDWA MCLs and MCLGs, although there are several additional chemicals that have criteria.	Since site groundwater is not used as a public drinking water supply, the criteria are not applicable. Since the site is adjacent to and upgradient of groundwater which is a potential drinking water supply, the criteria are relevant and appropriate to off-site groundwater. Because site groundwater is classified as potable, the Massachusetts MCLs are relevant and appropriate for site groundwater. Remedial actions including groundwater treatment and discharge will be designed and implemented to meet these standards.
	Massachusetts Office of Research and Standards Guidelines	To Be Considered	DEP Health Advisories are guidance criteria for drinking water and were used to develop discharge levels for surface water and groundwater. The DEP Office of Research and Standards issues guidelines for chemicals for which state MCLs have not been promulgated. These guidelines apply to non-chlorinated water supplies and represent a level at or below which adverse, non-cancer health effects are not expected to occur and which generally has an excess lifetime cancer risk of less than or equal to 10^{-6} .	Remedial actions including groundwater treatment and discharge will be designed and implemented in consideration of these standards.

TABLE 2-1. CHEMICAL-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE

Authority	Requirement	Status	Requirement Synopsis	Consideration in the RI/FS
Discharge to Publicly Owned Treatment Works				
Federal Regulatory Requirements	RCRA-Pretreatment Standards (40 CFR 403)	Applicable	Discharges to a POTW must comply with the POTW's EPA-approved pretreatment requirements. POTWs in the area with approved pretreatment programs are being identified and the discharge must be treated to those levels required by the program.	Any remedial action that includes a discharge to a POTW must be designed and implemented to meet these pretreatment standards.
Sediment				
Federal Requirements	There are no set maximum allowable residual levels for chemicals in sediments under federal law.			
Federal Criteria, Advisories, and Guidance	NOAA Effects Range-Low (ERL) values for marine and estuarine sediments (Long et al., 1995; Long and Morgan, 1990)	To Be Considered	The ERL value is equivalent to the lower 10th percentile of the available toxicity data, which is estimated to be the approximate concentration at which adverse effects are likely to occur in sensitive life stages and/or species of sediment-dwelling organisms.	ERLs were used for selecting Chemicals of Potential Concern and for characterizing ecological effects.
	U.S. DOE, Office of Environmental Management, Secondary Chronic Values (SCVs) (Jones et al., 1997)	To Be Considered	The SCVs are toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota.	SCVs were used for selecting Chemicals of Potential Concern and for characterizing ecological effects.
	U.S. EPA Sediment Quality Criterion (SQC) and Sediment Quality Benchmarks (SQBs) (USEPA, 1996)	To Be Considered	SQCs and SQBs were established to provide screening toxicity thresholds.	SQCs and SQBs were used for selecting Chemicals of Potential Concern and for characterizing ecological effects.
	NOAA Screening Quick Reference Tables, Threshold Effects Level (TEL) (Buchman, 1999)	To Be Considered	TELs represent the concentration below which adverse effects are expected to occur only rarely.	TELs were used for selecting Chemicals of Potential Concern and for characterizing ecological effects.
Other guidance	Ontario Ministry of Environment and Energy (OMEE) Lowest Effect Levels (LELs) for Freshwater Sediments (Persaud et al., 1993)	To Be Considered	The LEL value is the concentration at which the majority of the sediment-dwelling organisms are not affected.	LELs were used for selecting Chemicals of Potential Concern and for characterizing ecological effects.
	Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. Probable Effects Concentrations (PECs) (MacDonald et al., 2000)	To Be Considered	The PEC value is the concentration above which the adverse effects on sediment-dwelling organisms are likely to occur.	PECs were used for characterizing ecological effects and for developing cleanup goals.

TABLE 2-2. LOCATION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE

Authority	Requirements	Status	Requirement Synopsis	Applicability To Site Conditions
Wetlands, Floodplains, Streams, or Water Body				
Federal Requirements	Fish and Wildlife Coordination Act (16 U.S.C.. §661 <i>et seq.</i>); Fish and wildlife protection (40 C.F.R. §6.302(g))	Applicable	Any modification of a body of water requires consultation with the U.S. Fish and Wildlife Services and the appropriate state wildlife agency to develop measures to prevent, mitigate, or compensate for losses of fish and wildlife.	The site includes streams, wetlands, and downstream waterbodies. Planning and decision making will incorporate fish and wildlife protection considerations in consultation with the resource agencies.
	Executive Order 11990; "Protection of Wetlands" (40 C.F.R. Part 6, Appendix A)	Applicable	Under this requirement, no activity that adversely affects a wetland shall be permitted if a practicable alternative with lesser effects is available. Action to avoid, whenever possible, the long- and short-term impacts on wetlands and to preserve and enhance wetlands.	During identification, screening, and evaluation of alternatives, the effects on wetlands are evaluated. All practicable means will be used to minimize harm to the wetlands. Wetlands disturbed by well installation, maintenance, monitoring, or other remedial activities will be mitigated in accordance with requirements. The public will be kept informed of activities involving wetlands, as required.
	Clean Water Act, Section 404 (33 U.S.C.. § 1344); (40 C.F.R. Part 230 and 33 C.F.R. Parts 320-323)	Applicable	Under this requirement, no activity that adversely affects a wetland shall be permitted if a practicable alternative with lesser effects is available. Controls discharges of dredged or fill material to protect aquatic ecosystems.	Well installation, maintenance, monitoring or other remedial actions that include dredging or filling in wetlands will be implemented to meet these requirements.
	Executive Order 11988; "Floodplain Management" (40 C.F.R. Part 6, Appendix A)	Applicable	Action to avoid, whenever possible, the long- and short-term impacts associated with the occupancy and modifications of floodplains development, wherever there is a practical alternative. Promotes the preservation and restoration of floodplains so that their natural and beneficial value can be realized.	The site includes areas defined to be within the 100-year floodplain. Remedial actions that involve construction in the floodplain areas will include all practicable means to minimize harm to and preserve beneficial values of floodplains. Floodplains disturbed by remedial actions will be restored to their original conditions and utility.

TABLE 2-2. LOCATION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE

Authority	Requirements	Status	Requirement Synopsis	Applicability To Site Conditions
	Resource Conservation and Recovery Act (42 U.S.C. §6901 et seq.); Location Standards (40 CFR §264.18)	Relevant and Appropriate	This regulation places limitations on where RCRA TSDFs may be located. It also outlines the criteria for constructing a RCRA facility on a 100-year floodplain.	RCRA is relevant and appropriate due to the characteristics of the waste disposed prior to 1982. Remedial actions that include treatment, storage or disposal of wastes located on a 100-year floodplain must be designed, constructed, operated, and maintained to prevent washout of any hazardous waste by a 100-year flood, unless waste may be removed safely before flooding.
	Rivers and Harbors Act of 1899 (33 U.S.C. §401 et seq.); (33 CFR Part 320)	Relevant and Appropriate	Protects navigable rivers from unauthorized discharges or from unauthorized obstruction or alteration.	Remedial activities that cause alteration of navigable rivers will comply with this regulation.
State Requirements	Wetlands Protection Act (Mass. Gen. Laws ch. 131, §40); Wetlands Protection Regulations (310 CMR §10.00)	Applicable	Sets performance standards for dredging, filling, altering of inland wetlands and within 100 feet of a wetland. The requirement also defines wetlands based on vegetation type and requires that effects on wetlands be mitigated. Resource areas at the site covered by the regulations include banks, bordering vegetated wetlands, land under bodies of water, land subject to flooding, riverfront, and estimated habitats of rare wildlife.	The site includes significant wetlands. Alternatives requiring that work be completed within 100 feet of a defined wetland, will comply with these regulations. Mitigation of impacts on wetlands will be addressed.
	Massachusetts Clean Waters Act (Mass. Gen. Laws ch. 21, §§26-53); Water Quality Certification for Discharge of Dredged or Fill Material, Dredging, and Dredged Materials in Waters of the United States within the Commonwealth (314 CMR §9.00)	Applicable	Establishes criteria and standards for dredging, handling and disposal of fill material and dredged material.	The site includes significant wetlands. Applies to remediation activities which may occur in wetlands and buffer zones.
	Massachusetts Hazardous Waste Facility Siting Act (Mass. Gen. Laws ch. 21D, §§1-19); Hazardous Waste Facility Siting Regulations (990 CMR §1.00)	Relevant and Appropriate	These regulations outline criteria for new facilities or facilities improvements. Facilities may not be located within a wetland, bordering a vegetated wetland, or on a 100-year floodplain.	The Iron Horse Park Site includes areas defined as being within the 100-year floodplain. Remediation activities will be designed and implemented to comply with these regulations.

TABLE 2-2. LOCATION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE

Authority	Requirements	Status	Requirement Synopsis	Applicability To Site Conditions
Archaeological/Historic Sites				
Federal Regulatory Requirements	National Historic Preservation Act of 1966 (16 U.S.C. §470 et seq.); Protection of Historic Properties (36 CFR part 800)	Applicable	Section 106 of the NHPA requires federal agencies to take into account the effects of their undertakings on historic properties and afford the Advisory Council on Historic Preservation a reasonable opportunity to comment.	Actions which may impact historical properties for which these requirements apply (such as the Middlesex Canal), must be coordinated with the Advisory Council on Historic Preservation.
	Historic Sites Act of 1935 (16 U.S.C. §469 et seq.); National historic landmarks (36 CFR Part 65)	Applicable	The purpose of the National Historic Landmarks program is to identify and designate National Historic Landmarks, and encourage the long range preservation of nationally significant properties that illustrate or commemorate the history and prehistory of the United States.	Actions which may impact historical properties for which these requirements apply (such as the Middlesex Canal), must be coordinated with the Department of the Interior.
State Regulatory Requirements	Antiquities Act and Regulations (Mass. Gen. Laws. ch. 9, §§26-27; Massachusetts Historical Commission (Mass. Regs. Code tit. 950, §70.00); Antiquities Act and Regulations (Mass.Gen.Laws. ch. 9, §§26-27; Protection of Properties Included in the State Register of Historic Places (950 CMR §71.00)	Relevant and Appropriate but Applicable where EPA Activity is on State Property	Projects which are state-funded or state-licensed or which are on state property must eliminate, minimize, or mitigate adverse effects to properties listed in the register of historic places. Establishes requirements for review of impacts for state-funded or state-licensed projects and projects on state-owned property. Establishes state register of historic places. Establishes coordination with the National Historic Preservation Act.	Actions which may impact the historical, architectural, archaeological, or cultural qualities of a property, whether listed or not, must be coordinated with the Massachusetts Historical Commission.

TABLE 2-3. ACTION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE

Authority	Requirement	Status	Requirement Synopsis	Consideration in the RI/FS
Air				
Federal Requirements	Clean Air Act, NAAQS (40 CFR 50.6 - 50.7)	To Be Considered	This regulation specifies maximum primary and secondary 24-hour concentrations for particulate matter.	If remedial activities include excavation, standards for particulate matter will be met during excavation and handling of contaminated sediments. Activities during construction will include measures to suppress dust.
Massachusetts Requirements	Ambient Air Quality Standards (310 CMR 6.00)	Applicable	Sets primary and secondary ambient air quality standards for emissions of sulfur oxides, particulate matter, CO, ozone, nitrogen dioxide, and lead.	If remedial actions include treatment with air emissions, ambient air quality standards will not be exceeded. Dust standards will be complied with during any and all excavation of materials at the site.
	Massachusetts Air Pollution Control Regulations (310 CMR 7.09)	Relevant and Appropriate	Prohibits burning or emissions of dust which causes or contributes to a condition of air pollution. Standards for dust are contained in 310 CMR 7.09.	If remedial activities include excavation, these standards for particulate matter will be met.
	Air Pollution Control Regulations (310 CMR 7.00)	Applicable	Defines and regulates air pollution sources. Establishes emissions limitations for various processes and regions within the state. Sources require source approval and may require a study of health risks. All minor stationary sources are required to apply Best Available Control Technology (BACT) for each pollutant it would have the potential to emit. Major sources of volatile organic compounds (VOCs) are required to apply Lowest Achievable Emission Rate (LAER) and obtain offsets.	Any on-site treatment that generates an air emission source will comply with the substantive requirements of this regulation including: visible emissions, dust, noise, VOC and HOC emission limitations, and RACT emission limitations. No air sources will cause ambient air quality standards to be exceeded.
Federal Criteria, Advisories and Guidance	ACGIH (American Conference of Governmental Industrial Hygienists) Threshold Limiting Values (TLVs)	To Be Considered	TLVs are an estimate of the average safe airborne concentration of a substance in representative conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effect. These standards were issued as consensus standards for controlling air quality in work place environments.	TLVs could be used for assessing site inhalation risks for site remediation workers.
Massachusetts Criteria, Advisories, and Guidance	Massachusetts Threshold Effects Exposure Levels (TELs) and Allowable Ambient Limits (AALs) for Air (December 1995)	To Be Considered	These are guidelines used by Massachusetts DEP for air emission permit writing. Under the Clean Air Act Amendments, AALs may be utilized. TELs and AALs provide guidance when assessing significance of monitored and modeled residential contamination from air emissions. They also are used in evaluating worker safety.	AALs and TELs are to be considered when evaluating worker safety during site remediation, and for ambient air quality monitoring during any site remedy that involves disturbance of waste or contaminated materials.

TABLE 2-3. ACTION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE

Authority	Requirement	Status	Requirement Synopsis	Consideration in the RI/FS
Groundwater				
Massachusetts Requirements	Groundwater Discharge Permit Program (314 CMR 5.00)	Applicable	Establishes the program whereby discharges of pollutants to groundwater are regulated. Identifies activities which require permit for underground injection of discharge water. Specifies that discharge to sewer is preferred if available.	Any discharge to groundwater or leaching galleries not meeting exemption criteria shall comply with the substantive requirements of this regulation. The site is classified as a medium yield aquifer. No treated water discharge causing a violation of Massachusetts Ground Water Quality Standards (314 CMR 6.00) will be allowed.
	Ground Water Quality Standards (314 CMR 6.00)	Applicable	These standards consist of groundwater classifications, water quality criteria necessary to sustain the designated uses, and regulations to achieve the designated uses or maintain existing groundwater quality. Discharge limits are specified in 314 CMR 6.07, and monitoring requirements are identified in 314 CMR 6.08.	Discharge limits and monitoring requirements will be complied with for any on-site groundwater discharge. Groundwater in the vicinity of the Iron Horse Park Site is designated as Class I, fresh ground waters as a source of potable water. A large portion of the site overlies a medium yield aquifer.
	Underground Water Source Protection (310 CMR 27.00)	Applicable	Established to regulate underground injection of hazardous waste and other fluids with the potential to contaminate groundwater.	If the discharge from a remedial action is directed to groundwater the discharge will be treated, if necessary, so that these standards will be achieved.
Federal Criteria, Advisories, and Guidance	EPA Groundwater Protection Strategy (August 1984; NCP Preamble, Vol 55, No. 46, March 8, 1990, 40 CFR Part 300, p. 8733); Guidelines for Ground-Water Classification (November 1986)	To Be Considered	The Groundwater Protection Strategy provides a common reference for preserving clean groundwater and protecting the public health against the effects of past contamination. Guidelines for consistency in groundwater protection programs focus on the highest beneficial use of a groundwater aquifer and define three classes of groundwater. These documents defined Class I, II and III groundwaters.	The role of CSGWPPs (Comprehensive State Ground Water Protection Programs) in EPA Remediation Programs (April 1997) defers groundwater use determination to the state for states that have a CSGWPP that is endorsed by EPA and has provisions for site-specific decisions. For states that do not have an EPA-endorsed CSGWPP, groundwater use determinations will follow the NCP preamble. MA has an EPA-endorsed CSGWPP at this time. A large portion of the site overlies a medium yield aquifer.
	Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites. OSWER Directive 9200.4-17P, April 21, 1999	To Be Considered	This guidance sets criteria for evaluating monitored natural attenuation as a remedy at, among others, Superfund Sites.	Criteria for assessing the natural attenuation remedy for groundwater will be utilized.
Surface Water				
Federal Requirements	CWA Ambient Water Quality Criteria (AWQC) (40 CFR 120)	Relevant and Appropriate	Remedial actions involving contaminated surface water or groundwater must consider the uses of the water and the circumstances of the release or threatened release. Federal AWQC are health-based and ecologically based criteria developed for carcinogenic and non-carcinogenic compounds.	Any water discharged to surface water bodies will comply with this regulation. Treated water discharges to surface water will not cause an exceedence of AWQC.
	Toxic Pollutant Effluent Standards (40 CFR 129)	Applicable	Regulates surface water discharges of specific toxic pollutants, namely aldrin, dieldrin, DDT, endrin, toxaphene, benzidine, and PCBs.	Any water discharged to surface water bodies will meet the standards identified in this regulation. A permit will be required for any discharge to a surface water body that flows off-site. General permit requirements will be complied with for all discharges.

TABLE 2-3. ACTION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE

Authority	Requirement	Status	Requirement Synopsis	Consideration in the RI/FS
	Clean Water Act - National Pollutant Discharge Elimination System (NPDES) (40 CFR Parts 122 and 125)	Applicable	Establishes the specifications for discharging pollutants from any point source into the waters of the U.S.	Any water discharged to surface water bodies will comply with this regulation. A permit will be required for any discharge to a surface water body that flows off-site. General permit requirements will be complied with for all discharges.
	Clean Water Act - General Pretreatment Regulations for Existing and New Sources of Pollution (40 CFR 403)	Applicable	To control pollutants that may pass through or cause interference with the treatment process at a POTW, this regulation sets pretreatment standards through the National Categorical Standards or the General Pretreatment Regulations. It applies to the introduction of pollutants from non-domestic sources into POTWs. Discharges to a POTW must comply with the POTW's EPA-approved pretreatment requirements.	Utilization of the nearby Billerica POTW is a potential water discharge option. Pretreatment requirements would be adhered to. A permit in accordance with these regulations would be attained. As the discharge would be to an off-site facility, monitoring, recordkeeping, and reporting requirements would be adhered to.
Massachusetts Requirements	Surface Water Quality Standards (314 CMR 4.00)	Relevant and Appropriate	The standards: (1) designate the most sensitive uses for which the various waters of the Commonwealth shall be enhanced, maintained, and protected; (2) prescribe the minimum water quality criteria required to sustain the designated uses; and (3) contain regulations necessary to achieve the designated uses and maintain existing water quality. Specifies Federal AWQC to be used for effluent discharge limits or, where Federal limits are not available or are invalid, development of site-specific limits.	Waters from the site discharge to Content Brook, which is identified as part of the Shawsheen River Basin Area and is designated as Class B. Class B waters are designated as habitat for fish, other aquatic life, and for primary and secondary contact recreation. Discharges to surface water bodies on-site shall meet the requirements for Class B waters as specified at 314 CMR 4.05(3)(b).
	Surface Water Discharge Permit Program (314 CMR 3.00)	Applicable	This program regulates discharges of pollutants to surface waters in the Commonwealth. The program also regulates the outlets for such discharges and any treatment works associated with these discharges.	Any water discharged to surface water bodies will comply with this regulation. A permit will be required for any discharge to a surface water body that flows off-site. Substantive requirements will be complied with for all discharges.
	Sewer System Extension and Connection Permit Program (314 CMR 7.00)	Applicable	Establishes requirements for discharges to publicly owned treatment works (POTW) including permitting, calculation of flows, and permit conditions.	Utilization of the nearby Billerica POTW is a potential water discharge option. A permit in accordance with these regulations would be attained. As the discharge would be to an off-site facility, monitoring, recordkeeping, and reporting requirements would be adhered to.
<u>Sediment</u>				
Federal Requirements	RCRA - Standards Applicable to Generators of Hazardous Waste (40 CFR 262)	Applicable to any action that generates a hazardous waste	Generator requirements outline waste characterization, management of containers, packaging, labeling, and manifesting. Generator requirements apply to contaminated substances meeting the definition of RCRA-hazardous under 40 CFR 261. If contaminated substances at CERCLA sites are determined to be sufficiently similar to RCRA hazardous wastes, technical aspects of RCRA requirements are considered relevant and appropriate.	If removed from their location, hazardous substances must be handled, transported, and treated as RCRA hazardous waste. Waste characterization at the point of generation will be conducted to verify the applicability of these requirements.

TABLE 2-3. ACTION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE

Authority	Requirement	Status	Requirement Synopsis	Consideration in the RI/FS
	Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material (40 CFR 230)	Applicable	Requirements for discharges of dredged or fill material are outlined. Under this requirement, no activity that impacts a wetland will be permitted if a practicable alternative that has less impact on the wetland is available. If there is no other practicable alternative, impacts must be mitigated.	Any unavoidable impacts to the wetlands will be mitigated, and a wetlands restoration plan will be developed and implemented. Monitoring of impacted wetlands will be conducted for three growing seasons following completion of the remedy.
	Executive Order 11990; "Protection of Wetlands" (40 CFR Part 6, Appendix A)	Applicable	Under this requirement, no activity that adversely affects a wetland shall be permitted if a practicable alternative with lesser effects is available. Adverse impacts range from construction or dredging of wetlands, to watershed damages, to leaving the wetlands degraded by contamination. Action to avoid, whenever possible, the long- and short-term impacts on wetlands and to preserve and enhance wetlands.	Any remedial actions will minimize and mitigate site damages to the wetlands. Wetlands and buffer zones disturbed by remedial activities will be mitigated in accordance with requirements. The public will be kept informed of activities involving wetlands, as required.
Other Guidance	Ontario Ministry of Environment and Energy (OMEE) Lowest and Severe Effect Levels (LELs and SELs) for Freshwater Sediments (Persaud et. al. 1993)	To Be Considered	Provides guidelines for 16 organochlorine insecticides, PCBs, PAHs, metals, and nutrients. The guidelines establish three levels of effect: (1) No Effect Level, the level at which the chemical in the sediment does not affect fish or sediment-dwelling organisms and does not transfer through the food chain; (2) Lowest Effect Level, a level of contamination that has no effect on the majority of sediment-dwelling organisms; and (3) Severe Effect Level, a level of contamination that is likely to affect the health of sediment-dwelling organisms and at which the sediment is considered heavily polluted.	The guidelines provide the basis for sediment-quality evaluations dealing with the problem of contaminated sediments. Exceedence of an LEL or SEL may require further action.
Massachusetts Requirements	Hazardous Waste Management - Requirements for Generators of Hazardous Waste (310 CMR 30.300)	Applicable to any action that generates a hazardous waste	Generator requirements outline waste characterization, management of containers, packaging, labeling, and manifesting. Generator requirements apply to contaminated substances meeting the definition of hazardous under 310 CMR 100.	If removed from their location, substances meeting the definition of Massachusetts hazardous wastes must be handled, transported, and treated according to these rules. Waste characterization at the point of generation will be conducted to verify the applicability of these hazardous waste generator requirements.
	Wetlands Protection Act (Mass. Gen. Laws ch. 131, §40); Wetlands Protection Regulations (310 CMR §10.00)	Applicable	Sets performance standards for dredging, filling, altering of inland wetlands and within 100 feet of a wetland. The requirement also defines wetlands based on vegetation type and requires that effects on wetlands be mitigated. Resource areas at the site covered by the regulations include banks, bordering vegetated wetlands, land under bodies of water, land subject to flooding, riverfront, and estimated habitats of rare wildlife.	Any remedial actions completed within 100 feet of a defined wetland will also address mitigation of impacts on that wetland.

TABLE 2-4. REMEDIAL ACTION OBJECTIVES

MEDIUM AND AREA OF CONCERN	REMEDIAL ACTION OBJECTIVES (RAOs)	BASIS FOR RAO
Sediment		
B&M Pond	Protect benthic invertebrates from exposure to levels of COCs indicative of adverse effects.	The ERA/WRIA (M&E, 2006a) concluded that unacceptable risk to benthic invertebrates exists from exposure to sediment.
Unnamed Brook	Protect benthic invertebrates from exposure to levels of COCs indicative of adverse effects.	The ERA/WRIA (M&E, 2006a) concluded that unacceptable risk to benthic invertebrates exists from exposure to sediment.
Site-wide Groundwater		
Groundwater	Prevent direct contact exposures to groundwater in exceedance of appropriate ARARs or associated with a HI > 1 and/or ILCR > 10 ⁻⁶ to 10 ⁻⁴ for future residential use as tap water	The M&E HHRA (M&E, 2008a) concluded that the following analytes pose a risk to a future residential user: 1,2-dichloroethane, 1,4-dichlorobenzene, benzene, carbon tetrachloride, cis-1,3-dichloropropene, tetrachloroethene, trichloroethene, vinyl chloride, atrazine, bis(2-chloroethyl)ether, dibenz(a,h)anthracene, dieldrin, arsenic, cadmium, and manganese. As there are risk management exceedances associated with future groundwater use, federal/state MCLs are applicable, along with Massachusetts groundwater quality standards.
	Prevent migration of contaminated groundwater beyond the site compliance boundary.	Limit potential off-site exposures to residences with private wells.

TABLE 2-5. PRELIMINARY REMEDIATION GOALS (PRGs) FOR GROUNDWATER

Media/ Scenario	COC	Maximum Detection	Regulatory Criteria ¹		Risk-Based PRGs - Ingestion/Dermal/Inhalation ²				Additional Information				Selected PRG	Basis	
			Federal MCLs	MassDEP MCLs	ILCR			HQ = 1	Site-specific Range of Background Levels ³	MassDEP Background ⁴	Health Advisory ⁵	PQL			
					10 ⁻⁶	10 ⁻⁵	10 ⁻⁴								
Groundwater - ug/L (Residential Scenario)	1,2-Dichloroethane	23	5	5	0.39	3.9	39	N/A	--	--	--	0.1	5	MCL	
	1,4-Dichlorobenzene	7.5	75	5	1.5	15	150	6828	--	--	--	0.5	5	MMCL	
	Benzene	59	5	5	0.70	7.0	70	32	--	--	--	0.5	5	MCL	
	Carbon tetrachloride	120	5	5	0.30	3.0	30	6.1	--	--	--	0.1	5	MCL	
	cis-1,3-Dichloropropene	8.6	--	--	0.49	4.9	49	101	--	--	--	0.1	0.49	ILCR = 10 ⁻⁶	
	Tetrachloroethene	39	5	5	0.069	0.69	6.9	73	--	--	--	0.05	5		MCL
	Trichloroethene	75	5	5	0.083	0.83	8.3	2.8	--	--	--	0.05	5		MCL
	Vinyl chloride	0.74	2	2	0.011	0.11	1.1	29	--	--	--	0.05	2		MCL
	Atrazine	1.9	3	3	0.23	2.3	23	337	--	--	--	1	3	MCL	
	Bis(2-chloroethyl)ether	0.7	--	--	0.048	0.48	4.8	N/A	--	--	--	0.5	0.5	PQL	
	Dibenz(a,h)anthracene	0.05	--	--	0.0078	0.078	0.78	N/A	--	--	--	0.1	0.1	PQL	
	Dieldrin	0.013	--	--	0.0022	0.022	0.22	0.36	--	--	--	0.01	0.01	PQL	
	Arsenic	281	10	10	0.038	0.38	3.8	3.1	7.9 - 48.5	5.5	--	0.5	10	MCL	
	Cadmium	22.3	5	5	N/A	N/A	N/A	4.8	--	4.2	--	1	5	MCL	
	Lead ⁶	29	15	15	N/A	N/A	N/A	N/A	12.5	8.8	--	1	15	MCL	
	Manganese	22600	--	--	N/A	N/A	N/A	225	14.5 - 1180	--	300	1	300	Health Adv.	

Notes

COC - Contaminant of Concern

MCL - Maximum Contaminant Level

MMCL - Massachusetts Maximum Contaminant Level

ILCR - Incremental Lifetime Cancer Risk

HQ - Hazard Quotient

N/A - Not carcinogenic, or a carcinogen was not evaluated for potential non-carcinogenic effects

PQL - Practical Quantification Limit; While it may be possible to achieve lower limits, those that are reasonably achievable have been included.

1. Regulatory Criteria only include regulatory requirements considered applicable or relevant and appropriate; -- = no criterion

2. Risk-based PRGs have only been calculated for those COCs shown to drive risk in the supplemental human health risk assessment (M&E, 2008a).

3. Site-specific background concentrations taken from results presented in the RI report (M&E, 1997) for locations (MW-200S/D/B and OW-05) sampled in March/April and July 1995; -- = not detected

4. From *Background Documentation for the Development of the Massachusetts Contingency Plan (MCP) Numerical Standards* (MassDEP, 1994).

5. Health Advisory on Manganese (EPA-822-R-04-003; January 2004); -- = not applicable

6. Lead was identified in the Supplemental HHRA as a risk-driver, however, it was not quantitatively evaluated.

TABLE 2-6
PRELIMINARY REMEDIATION GOALS - SEDIMENT
IRON HORSE PARK SUPERFUND SITE - OU-4

COC	NOEC ⁽¹⁾	LOEC ⁽²⁾	Selected PRG ⁽³⁾
<u>PAHs (ug/kg)</u>			
Total PAH	1,932	12,097	4,834
<u>Pesticides (ug/kg)</u>			
4,4'-DDD	14.5	18	16
<u>PCBs (mg/kg)</u>			
Total PCBs ⁽⁴⁾			1
<u>Metals (mg/kg)</u>			
Chromium	14	34	22
Copper	19	210	63
Lead	35	380	115
Vanadium	19	28	23
Zinc	110	150	128

Notes

⁽¹⁾ NOEC set as the higher of the concentrations observed at locations with no observed effects

⁽²⁾ LOEC set as the lower of the concentrations observed at locations with observed toxicity among the values that exceeded NOECs

⁽³⁾ The MATC (set as the geometric mean between the NOEC and LOEC values) has been selected as the PRG for each COC except Total PCBs.

⁽⁴⁾ See Appendix A for discussion of Total PCBs PRG development.

COC - Contaminant of Concern

NOEC - No observed effects concentration

LOEC - Lowest observed effects concentration

MATC - Maximum Acceptable Toxic Concentration

DL - Value represents the detection limit - compound was not detected

TABLE 2-7. MEDIA POTENTIALLY REQUIRING REMEDIATION

Media	Location	Volume / Area	Potentially Requiring Remediation [basis]
GROUNDWATER			
	<u>Overburden Flow Zone</u>		
	33 out of 43 monitoring wells sampled in winter 2005/2006 had at least one PRG exceedance. These locations are presented on Figure 2-2 to provide an indication of on-site contamination nature and extent.		
	<u>Bedrock Flow Zone</u>		
	10 out of 17 monitoring wells sampled in winter 2005/2006 had at least one PRG exceedance. These locations are presented on Figure 2-3 to provide an indication of on-site contamination nature and extent.		
SEDIMENT			
	<u>Unnamed Brook and associated wetlands</u>		
	Total length of narrow stream beds =	8556 ft	[Fig. 2-4]
	<u>B&M Pond and associated wetlands</u>		
	Total area of pond/wetland area =	200000 ft ²	[Fig. 2-4]
	Assumed depth of contamination =	0.5 ft	
	Total volume of contaminated sediments =	3704 bank yd ³	
	Assumed depth of excavation =	1 ft	
	Total volume of excavated sediments =	7407 bank yd ³	

TABLE 2-8
SITE GROUNDWATER MONITORING WELLS

Area of Concern	Monitoring Well	Flowzone	Dates Sampled			Notes
			Remedial Investigation		2005-06	
Background	MW-200B	BR	March/April-95	July-95	--	
	MW-200D	DOB	March/April-95	July-95	--	
	MW-200S	SOB	March/April-95	July-95	--	
	OW-05	BR	March/April-95	July-95	--	
	OW-06	DOB	--	--	--	
	OW-52	BR	--	--	--	
	OW-53	DOB	--	--	--	
B&M Railroad Landfill	MW-01	BR	--	--	December-05	
	MW-01A	DOB	March/April-95	--	December-05	
	MW-01B	DOB	--	--	December-05	
	MW-01C	SOB	March/April-95	--	December-05	
	MW-213B	BR	March/April-95	July-95	December-05	
	MW-213D	DOB	March/April-95	July-95	December-05	
	MW-213S	SOB	March/April-95	July-95	December-05	
	MW-214B	BR	March/April-95	July-95	--	
	MW-214D	DOB	March/April-95	July-95	--	
	MW-214S	SOB	March/April-95	July-95	December-05	
	MW-215B	BR	March/April-95	July-95	--	
	MW-215D	DOB	March/April-95	July-95	--	
	MW-215B	BR	March/April-95	July-95	December-05	
	OW-34	BR	March/April-95	July-95	--	Potentially Upgradient; Also see CSA
	OW-35	SOB	March/April-95	July-95	December-05	Potentially Upgradient; Also see CSA
	OW-36	SOB	March/April-95	July-95	--	Potentially Upgradient; Also see CSA
	OW-49	BR	March/April-95	July-95	December-05	
	OW-50	DOB	March/April-95	July-95	December-05	
	OW-51	SOB	--	--	December-05	
RSI Landfill	MW-207B	BR	March/April-95	July-95	December-05	Potentially Upgradient; Also see Asbestos Landfill
	MW-210B	BR	March/April-95	July-95		
	MW-210S	SOB	March/April-95	July-95	December-05	
	MW-211B	BR	March/April-95	July-95		
	MW-211D	DOB	March/April-95	July-95	December-05	
	MW-211S	SOB	March/April-95	July-95	December-05	
	MW-212B	BR	March/April-95	July-95	December-05	
	MW-212D	DOB	March/April-95	July-95	December-05	
	MW-212S	SOB	March/April-95	July-95	--	
	OW-01	BR	March/April-95	July-95	December-05	
	OW-02	DOB	March/April-95	July-95	December-05	
	OW-03	SOB	March/April-95	July-95	--	
	OW-25	DOB	March/April-95	July-95	December-05	Potentially Upgradient; Also see Asbestos Landfill
	OW-26	SOB	March/April-95	July-95	December-05	Potentially Upgradient; Also see Asbestos Landfill
	OW-27	SOB	March/April-95	July-95	--	Potentially Upgradient; Also see Asbestos Landfill

TABLE 2-8
SITE GROUNDWATER MONITORING WELLS

Area of Concern	Monitoring Well	Flowzone	Dates Sampled			Notes
			Remedial Investigation		2005-06	
Asbestos Landfill	MW-207B	BR	March/April-95	July-95	December-05	Potentially Upgradient; Also see RSI Landfill
	MW-305D	DOB	--	--	February-06	Upgradient
	MW-305S	SOB	--	--	February-06	Upgradient
	MW-306S	SOB	--	--	February-06	Upgradient
	MW-307B	BR	--	--	February-06	
	MW-307D	DOB	--	--	February-06	
	MW-307S	SOB	--	--	February-06	
	MW-308B	BR	--	--	February-06	
	OW-07	DOB	March/April-95	July-95	February-06	
	OW-08	SOB	March/April-95	July-95	February-06	
	OW-25	DOB	March/April-95	July-95	December-05	Potentially Upgradient; Also see RSI Landfill
	OW-26	SOB	March/April-95	July-95	December-05	Potentially Upgradient; Also see RSI Landfill
	OW-27	SOB	March/April-95	July-95	--	Potentially Upgradient; Also see RSI Landfill
Old B&M Oil/Sludge Recycling Area	MW-201B	BR	March/April-95	July-95	--	Destroyed
	MW-201D	DOB	March/April-95	July-95	--	Destroyed
	MW-201S	SOB	March/April-95	July-95	--	Destroyed
	MW-202B	BR	March/April-95	July-95	February-06	
	MW-202D	DOB	March/April-95	July-95	February-06	
	MW-202S	SOB	March/April-95	July-95	February-06	
	MW-203B	BR	March/April-95	July-95	December-05	
	MW-203D	DOB	March/April-95	July-95	December-05	
	MW-203S	SOB	March/April-95	July-95	December-05	
	MW-301B	BR	--	--	February-06	
	MW-301D	DOB	--	--	February-06	
	MW-301S	SOB	--	--	February-06	
	MW-302S	SOB	--	--	February-06	
	MW-303S	SOB	--	--	February-06	
	OW-17	BR	March/April-95	July-95	--	
	OW-18	DOB	March/April-95	July-95	--	
	OW-19	SOB	March/April-95	July-95	--	
	OW-37	BR	March/April-95	July-95	December-05	Also see CSA
	OW-38	DOB	March/April-95	July-95	December-05	Also see CSA
	OW-41	DOB	March/April-95	July-95	--	Destroyed
	OW-42	SOB	March/April-95	July-95	--	Destroyed
	OW-43	SOB	March/April-95	July-95	--	Destroyed
B&M Locomotive Shop Disposal Areas (A&B)	MW-204B	BR	March/April-95	July-95	--	Slightly upgradient
	MW-204D	DOB	March/April-95	July-95	--	Slightly upgradient
	MW-204S	SOB	March/April-95	July-95	December-05	Slightly upgradient
	MW-205B	BR	March/April-95	July-95	--	
	MW-205D	DOB	March/April-95	July-95	--	
	MW-205S	SOB	March/April-95	July-95	December-05	
	MW-206B	BR	March/April-95	July-95	--	
	MW-206D	DOB	March/April-95	July-95	December-05	
	MW-206S	SOB	March/April-95	July-95	December-05	
	OW-39	DOB	March/April-95	July-95	--	
	OW-40	SOB	March/April-95	July-95	--	

TABLE 2-8
SITE GROUNDWATER MONITORING WELLS

Area of Concern	Monitoring Well	Flowzone	Dates Sampled			Notes
			Remedial Investigation		2005-06	
Contaminated Soils Area (CSA)	OW-20	DOB	March/April-95	July-95	December-05	Potentially Downgradient; Also see Asbestos Lagoons
	OW-21	SOB	March/April-95	July-95	--	Potentially Downgradient; Also see Asbestos Lagoons
	OW-34	BR	March/April-95	July-95	--	Also see B&M Railroad Landfill
	OW-35	SOB	March/April-95	July-95	December-05	Also see B&M Railroad Landfill
	OW-36	SOB	March/April-95	July-95	--	Also see B&M Railroad Landfill
	OW-37	BR	March/April-95	July-95	December-05	Also see Old B&M Oil/Sludge Recycling Area
	OW-38	DOB	March/April-95	July-95	December-05	Also see Old B&M Oil/Sludge Recycling Area
	MW-208B	BR	March/April-95	July-95	December-05	Also see Asbestos Lagoons
	MW-208D	DOB	March/April-95	July-95	December-05	Also see Asbestos Lagoons
	MW-208S	SOB	March/April-95	July-95	December-05	Also see Asbestos Lagoons
	MW-209B	BR	March/April-95	July-95	December-05	Also see Asbestos Lagoons
	MW-304B	BR	--	--	February-06	
	MW-304D	DOB	--	--	February-06	
	MW-304S	SOB	--	--	February-06	
Asbestos Lagoons	MW-208B	BR	March/April-95	July-95	December-05	Upgradient; Also see CSA
	MW-208D	DOB	March/April-95	July-95	December-05	Upgradient; Also see CSA
	MW-208S	SOB	March/April-95	July-95	December-05	Upgradient; Also see CSA
	MW-209B	BR	March/April-95	July-95	December-05	Sidegradient; Also see CSA
	OW-09	BR	March/April-95	July-95	December-05	
	OW-10	DOB	March/April-95	July-95	December-05	
	OW-11	SOB	March/April-95	July-95	--	
	OW-12	SOB	March/April-95	July-95	December-05	
	OW-13	DOB	March/April-95	July-95	--	Upgradient/Sidegradient
	OW-14	SOB	March/April-95	July-95	--	Upgradient/Sidegradient
	OW-20	DOB	March/April-95	July-95	December-05	Sidegradient; Also see CSA
	OW-21	SOB	March/April-95	July-95	--	Sidegradient; Also see CSA

Notes

BR - Bedrock

DOB - Deep Overburden

SOB - Shallow Overburden

TABLE 2-9. GROUNDWATER SAMPLING RESULTS - WINTER 2005-2006 - COMPARISON TO PRGs

ANALYTE	PRG	MW-01 NX 12/14/2005	MW-01A NX 12/15/2005	MW-01B NX 12/14/2005	MW-01C NX 12/14/2005	MW-202B NX 2/20/2006	MW-202D NX 2/20/2006	MW-202S NX 2/20/2006	MW-203B NX 12/15/2005	MW-203D NX 12/15/2005	MW-203S NX 12/15/2005	MW-204S NX 12/15/2005	MW-205S NX 12/15/2005	MW-206D NX 12/13/2005	MW-206S NX 12/13/2005	MW-207B AV 12/13/2005	MW-208B NX 12/16/2005
VOCs (ug/L)																	
1,2-Dichloroethane	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.095 J	0.5 U	0.5 U	0.5 U	0.5 U	2.6	1.7
1,4-Dichlorobenzene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	7.5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.145 J	0.5 U
Benzene	5	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1.1 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ
Carbon Tetrachloride	5	0.5 U	0.5 U	0.5 U	0.5 U	0.16 J	0.5 U	120	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.103 J	0.5 U
cis-1,3-Dichloropropene	0.49	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Tetrachloroethene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.23 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	12	0.5 U
Trichloroethene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	9.05	0.5 U
Vinyl Chloride	2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
SVOCs (ug/L)																	
Atrazine	3	1 U	0.19 J	1.1 U	1 U	-- R	1.9 J	-- R	1.1 U	0.27 J	1 U	1.1 U	1.1 U	1 U	1 U	0.255 J	1 U
Bis(2-chloroethyl)ether	0.5	0.05 U	0.53 U	0.57 U	0.05 U	0.5 U	0.5 U	0.5 UJ	0.57 U	0.53 U	0.52 U	0.53 U	0.53 U	0.05 U	0.05 U	0.395 J	0.52 U
Dibenz(a,h)anthracene	0.1	0.1 U	0.11 U	0.11 U	0.1 U	0.1 U	0.1 U	0.1 UJ	0.11 U	0.11 U	0.1 U	0.11 U	0.11 U	0.1 U	0.1 U	0.1 U	0.026 J
Pesticides/PCBs (ug/L)																	
Dieldrin	0.01	NA	NA	NA	NA	NA	NA	0.01 UJ	NA	NA	0.01 UJ	NA	0.01 U	NA	0.01 U	0.01 UJ	NA
Metals (ug/L)																	
Arsenic	10	4.3	5.8	0.21 J	0.054 J	3.5	0.5 U	17.2	0.86	1.5	5.8	2.5	0.39 J	0.25 J	0.62	5.8 J	4.2
Cadmium	5	7.1	1.8	22.3	0.15 J	0.28 J	0.063 J	0.14 J	0.65 J	0.088 J	1 U	0.97 J	0.11 J	0.19 J	0.59 J	0.83 J	1 U
Lead	15	28.8	10.5	6	1 U	0.83 J	0.86 J	0.58 J	0.51 J	0.36 J	1 U	7.4	6.3	1 U	1 U	5.5 J	0.37 J
Manganese	300	287 J	93.9 J	290	106 J	81.8	12.2	220	29.7 J	256 J	1010 J	22400 J	397 J	57.8 J	532 J	431 J	281

Previously Sampled?: N Y N Y Y Y Y Y Y Y Y Y Y Y Y Y Y Y

Notes
NX - Normal Field Sample
AV - Average of Field Duplicates
PRG - Preliminary Remediation Goal
Shaded values indicate exceedance of PRG
NA - Not Analyzed

TABLE 2-9. GROUNDWATER SAMPLING RESULTS - WINTER 2005-2006 - COMPARISON TO PRGs

ANALYTE	PRG	MW-208D NX 12/16/2005	MW-208S NX 12/16/2005	MW-209B NX 12/21/2005	MW-210S NX 12/20/2005	MW-211D NX 12/20/2005	MW-211S NX 12/20/2005	MW-212B NX 12/20/2005	MW-212D AV 12/20/2005	MW-213B NX 12/19/2005	MW-213D NX 12/19/2005	MW-213S AV 12/19/2005	MW-214S NX 12/19/2005	MW-215B NX 12/19/2005	MW-301B NX 2/23/2006	MW-301D NX 2/23/2006	MW-301S NX 2/23/2006
VOCs (ug/L)																	
1,2-Dichloroethane	5	0.5 U	0.5 U	21	0.5 U	0.5 U	0.5 U	1.6	0.5 U	4.6	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
1,4-Dichlorobenzene	5	0.5 U	0.5 U	0.5 U	2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Benzene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Carbon Tetrachloride	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
cis-1,3-Dichloropropene	0.49	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 UJ	0.5 UJ	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U
Tetrachloroethene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Trichloroethene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	16	4.8	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Vinyl Chloride	2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
SVOCs (ug/L)																	
Atrazine	3	1.1 U	1.1 U	-- R	5 U	5 U	5 U	5 U	5 U	1 U	5 U	5 U	0.36 J	1.1 U	-- R	-- R	-- R
Bis(2-chloroethyl)ether	0.5	0.54 U	0.56 U	0.32 J	0.66 UJ	0.5 UJ	0.82 UJ	0.1 J	0.51 UJ	0.31 J	0.5 UJ	-- R	0.53 U	0.57 U	0.5 U	0.5 U	0.5 U
Dibenz(a,h)anthracene	0.1	0.05 J	0.05 J	0.1 UJ	0.13 UJ	0.1 UJ	0.16 UJ	0.1 UJ	0.1 UJ	0.019 J	0.1 UJ	5 U	0.024 J	0.027 J	0.1 U	0.1 U	0.1 U
Pesticides/PCBs (ug/L)																	
Dieldrin	0.01	NA	NA	NA	NA	NA	0.01 U	NA	NA	NA	NA	-- R	0.01 UJ	NA	NA	NA	0.01 UJ
Metals (ug/L)																	
Arsenic	10	0.11 J	101	4.4	66.1	281	99.5	32.9	20.25	5.1	0.42 J	1.7	88.8	4.2	2.7	7	22.1
Cadmium	5	0.1 J	1 U	1 U	1 U	1 U	1 U	1 U	0.079 J	1.2	1 U	0.075 J	1 U	0.088 J	1 U	0.061 J	1 U
Lead	15	1 UJ	1.9 J	1 U	1 UJ	1 U	1 UJ	0.37 J	0.375 J	17.3 J	0.32 J	3.35 J	0.36 J	0.37 J	2.8	4.3	1 U
Manganese	300	1690	1050	1290	2770	5140	1180	2770	1040.5	270	224	773.5	4550	30.7	130	238	599

Previously Sampled?: Y Y Y Y Y Y Y Y Y Y Y Y Y Y Y N N N

Notes
NX - Normal Field Sample
AV - Average of Field Duplicates
PRG - Preliminary Remediation Goal
Shaded values indicate exceedance of PRG
NA - Not Analyzed

TABLE 2-9. GROUNDWATER SAMPLING RESULTS - WINTER 2005-2006 - COMPARISON TO PRGs

ANALYTE	PRG	MW-302S NX 2/20/2006	MW-303S NX 2/20/2006	MW-304B NX 2/21/2006	MW-304D AV 2/21/2006	MW-304S NX 2/21/2006	MW-305D NX 2/21/2006	MW-305S NX 2/21/2006	MW-306S NX 2/23/2006	MW-307B NX 2/22/2006	MW-307D NX 2/22/2006	MW-307S NX 2/22/2006	MW-308B NX 2/22/2006	OW-01 NX 12/20/2005	OW-02 NX 12/20/2005	OW-07 NX 2/22/2006	OW-08 NX 2/22/2006
VOCs (ug/L)																	
1,2-Dichloroethane	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	4.8	0.5 U	0.5 U	23	11	0.5 U	8.5	0.74	0.5 U	0.54 U	2.7 U
1,4-Dichlorobenzene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.37 J	0.5 U	0.5 U	0.5 U	0.42 J	0.5 U	0.26 J	0.5 U	0.5 U	0.5 U	1.6
Benzene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.29 J	0.5 U	0.5 U	0.5 U	0.5 U	6.6 J	0.2 J	0.5 U	0.5 U	0.5 U	59
Carbon Tetrachloride	5	0.5 U	0.39 J	0.5 U	0.5 U	0.5 U	0.23 J	0.5 U	0.5 U	0.5 U	0.22 J	0.42 J	0.27 J	0.5 U	0.5 U	0.5 U	0.36 J
cis-1,3-Dichloropropene	0.49	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	1.2 J	0.5 U	0.5 U	0.5 U	0.5 U	8.6
Tetrachloroethene	5	0.5 U	0.5 U	0.5 U	0.34 J	0.085 J	0.5 U	1.6	0.5 U	0.5 U	0.26 J	0.5 U	0.26 J	0.5 U	0.5 U	0.5 U	0.5 U
Trichloroethene	5	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.37 J	0.4 J	0.5 U	0.5 U	0.96	0.5 U	75	1.5	0.5 U	4.6	0.13 J
Vinyl Chloride	2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.66	0.74	0.5 U	0.5 U	0.5 U	0.5 U
SVOCs (ug/L)																	
Atrazine	3	-- R	-- R	-- R	-- R	-- R	-- R	-- R	-- R	-- R	-- R	-- R	-- R	5 U	5 UJ	-- R	-- R
Bis(2-chloroethyl)ether	0.5	0.5 U	0.5 U	0.058 J	0.5 U	0.5 U	0.55	0.059 J	0.5 U	0.53	0.7	0.5 U	0.66	0.065 J	0.58 UJ	0.093 J	0.5 U
Dibenz(a,h)anthracene	0.1	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.12 UJ	0.12 UJ	0.1 U	0.1 U
Pesticides/PCBs (ug/L)																	
Dieldrin	0.01	NA	NA	0.01 UJ	0.01 UJ	0.01 UJ	0.01 UJ	0.013	NA	NA	NA	NA	0.01 UJ	NA	NA	0.01 UJ	0.01 UJ
Metals (ug/L)																	
Arsenic	10	1.1	16.1	6.4	0.56	0.5 U	3.8	3.3	14.5	10.6	2.8	8.6	1.4	2.4	11.9	7.2	14.4
Cadmium	5	0.061 J	1 U	1 U	0.0765 J	0.082 J	0.15 J	1 U	1 U	1 U	1 U	1 U	0.12 J	0.18 J	0.38 J	1 U	1 U
Lead	15	2.5	7.9	0.16 J	0.35 J	1 U	1 U	1 U	1 U	0.13 J	1 U	0.12 J	0.15 J	1 UJ	0.24 J	0.25 J	0.11 J
Manganese	300	45.1	346	75.7	137.5	6.6	6440	1730	205	37.3	133	409	149	158	2320	2110	567
Previously Sampled?:		N	N	N	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y

Notes
NX - Normal Field Sample
AV - Average of Field Duplicates
PRG - Preliminary Remediation Goal
Shaded values indicate exceedance of PRG
NA - Not Analyzed

TABLE 2-9. GROUNDWATER SAMPLING RESULTS - WINTER 2005-2006 - COMPARISON TO PRGs

ANALYTE	PRG	OW-09 NX 12/15/2005	OW-10 NX 12/15/2005	OW-12 NX 12/15/2005	OW-20 NX 12/21/2005	OW-25 NX 12/13/2005	OW-26 NX 12/13/2005	OW-35 NX 12/21/2005	OW-37 NX 12/21/2005	OW-38 NX 12/21/2005	OW-49 NX 12/14/2005	OW-50 NX 12/14/2005	OW-51 NX 12/14/2005
<u>VOCs (ug/L)</u>													
1,2-Dichloroethane	5	2.6	2.6	0.5 U	0.66	1.3	0.5 U	0.5 U	0.47 J	0.5 U	5	0.5 U	0.5 U
1,4-Dichlorobenzene	5	0.32 J	0.31 J	0.5 U	0.6	0.5 U	0.27 J	0.5 U	0.5 U	1.7	0.14 J	0.5 U	0.5 U
Benzene	5	0.5 U	0.5 U	0.37 J	0.26 J	0.5 U	0.5 U	0.5 U	0.5 U	0.63	0.5 U	0.5 U	0.5 U
Carbon Tetrachloride	5	0.5 U	0.5 U	0.5 U	7.8 J	0.5 U	0.5 U	0.5 U	0.56	37	0.5 U	0.5 U	0.5 U
cis-1,3-Dichloropropene	0.49	0.5 U	0.5 U	0.5 UJ	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ
<u>SVOCs (ug/L)</u>													
Tetrachloroethene	5	3.2	3.2	0.5 U	39	4.4	0.5 U	0.5 U	1.3	14	0.5 U	0.5 U	0.5 U
Trichloroethene	5	2.2	2.2	0.5 U	7 J	3.2	0.08 J	0.5 U	0.28 J	2	7.8	0.18 J	0.5 U
Vinyl Chloride	2	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
<u>Pesticides/PCBs (ug/L)</u>													
Atrazine	3	1.1 U	0.13 J	1.1 U	-- R	0.28 J	1 U	-- R	-- R	-- R	1 U	1 U	1 U
Bis(2-chloroethyl)ether	0.5	0.44 J	0.058 J	0.57 U	0.5 UJ	0.02 J	0.11 J	0.5 UJ	0.5 UJ	0.5 UJ	0.21 J	0.034 J	0.058 J
Dibenz(a,h)anthracene	0.1	0.11 U	0.11 U	0.11 U	0.1 UJ	0.1 U	0.1 U	0.1 UJ	0.1 UJ	0.1 UJ	0.1 U	0.1 U	0.1 U
<u>Metals (ug/L)</u>													
Dieldrin	0.01	0.01 U	NA	NA	0.01 U	NA	0.01 U	0.01 U	NA	NA	NA	NA	NA
<u>Metals (ug/L)</u>													
Arsenic	10	1.5	0.25 J	13.6	10.7	2 J	24.7	8.3	7.4	8.1	0.48 J	6.9	23.1
Cadmium	5	18.3	0.96 J	0.051 J	0.056 J	1.3 J	1 U	1 U	1 U	0.41 J	0.43 J	0.18 J	1 U
Lead	15	6.1 J	0.6 J	1 UJ	1 U	10 U	0.78 J	0.73 J	1 U	1 U	1 U	1.1	1 U
Manganese	300	22600	2820	82.2	3480	5970 J	7.6 J	327	1390	1700	516 J	1350 J	1470 J

Previously Sampled?: Y Y Y Y Y Y Y Y Y Y Y Y Y N

Notes
NX - Normal Field Sample
AV - Average of Field Duplicates
PRG - Preliminary Remediation Goal
Shaded values indicate exceedance of PRG
NA - Not Analyzed

TABLE 2-10a. COMPARISON OF HISTORICAL PRG EXCEEDANCES IN GROUNDWATER BY AREA OF CONCERN - OVERBURDEN/BEDROCK COMBINED

Monitoring Wells Sampled During Both 1995 Remedial Investigation and 2005/06 Monitoring Rounds

	Wells Sampled	# Wells Sampled	1995 Remedial Investigation Wells with One or More PRG Exceedances						2005-2006 Investigation Wells with One or More PRG Exceedances					
			Total	cVOCs	BTEX	SVOCs	Metals	Pesticides	Total	cVOCs	BTEX	SVOCs	Metals	Pesticides
B&M Railroad Landfill	MW-01A, MW-01C, MW-213S, MW-213D, MW-213B, MW-214S, MW-215B, OW-35, OW-49, OW-50	10	7	3 MW-213B, MW-213D, OW-49	0 No Exceedances	0 No Exceedances	6 MW-213S, MW-213D, MW-214S, OW-35, OW-49, OW-50	0 No Exceedances	6	2 MW-213B, OW-49	0 No Exceedances	0 No Exceedances	6 MW-213S, MW-213B, MW-214S, OW-35, OW-49, OW-50	0 No Exceedances
RSI Landfill	MW-207B, MW-210S, MW-211S, MW-211D, MW-212D, MW-212B, OW-01, OW-02, OW-25, OW-26	10	10	2 MW-207B, OW-01	0 No Exceedances	0 No Exceedances	8 MW-210S, MW-211S, MW-211D, MW-212D, MW-212B, OW-02, OW-25, OW-26	0 No Exceedances	9	1 MW-207B	0 No Exceedances	0 No Exceedances	9 MW-207B, MW-210S, MW-211S, MW-211D, MW-212D, MW-212B, OW-02, OW-25, OW-26	0 No Exceedances
Asbestos Landfill	MW-207B, OW-07, OW-08, OW-25, OW-26	5	5	2 MW-207B, OW-07	1 OW-08	0 No Exceedances	4 OW-07, OW-08, OW-25, OW-26	0 No Exceedances	5	2 MW-207B, OW-08	1 OW-08	0 No Exceedances	5 MW-207B, OW-07, OW-08, OW-25, OW-26	0 No Exceedances
Contaminated Soils Area	MW-208S, MW-208D, MW-208B, MW-209B, OW-20, OW-35, OW-37, OW-38	8	8	1 MW-209B	0 No Exceedances	0 No Exceedances	8 MW-208S, MW-208D, MW-208B, MW-209B, OW-20, OW-35, OW-37, OW-38	0 No Exceedances	7	3 MW-209B, OW-20, OW-38	0 No Exceedances	0 No Exceedances	7 MW-208S, MW-208D, MW-209B, OW-20, OW-35, OW-37, OW-38	0 No Exceedances
B&M Locomotive Shop Disposal Areas (A&B)	MW-204S, MW-205S, MW-206S, MW-206D	4	2	0 No Exceedances	0 No Exceedances	0 No Exceedances	2 MW-204S, MW-205S	0 No Exceedances	3	0 No Exceedances	0 No Exceedances	0 No Exceedances	3 MW-204S, MW-205S, MW-206S	0 No Exceedances
Old B&M Oil/Sludge Recycling Area	MW-202S, MW-202D, MW-202B, MW-203S, MW-203D, MW-203B, OW-37, OW-38	8	4	0 No Exceedances	0 No Exceedances	0 No Exceedances	4 MW-203D, MW-203S, OW-37, OW-38	0 No Exceedances	4	2 MW-202S, OW-38	0 No Exceedances	0 No Exceedances	4 MW-202S, MW-203S, OW-37, OW-38	0 No Exceedances
Asbestos Lagoons	MW-208S, MW-208D, MW-208B, MW-209B, OW-09, OW-10, OW-12, OW-20	8	8	1 MW-209B	0 No Exceedances	0 No Exceedances	8 MW-208S, MW-208D, MW-208B, MW-209B, OW-09, OW-10, OW-12, OW-20	0 No Exceedances	7	2 MW-209B, OW-20	0 No Exceedances	0 No Exceedances	7 MW-208S, MW-208D, MW-209B, OW-09, OW-10, OW-12, OW-20	0 No Exceedances
TOTAL ¹		53	44	9	1	0	40	0	41	12	1	0	41	0

TABLE 2-10b. COMPARISON OF HISTORICAL PRG EXCEEDANCES IN GROUNDWATER BY AREA OF CONCERN - OVERBURDEN

Overburden Wells Sampled During Both 1995 Remedial Investigation and 2005/06 Monitoring Rounds

	Wells Sampled	# Wells Sampled	1995 Remedial Investigation Wells with One or More PRG Exceedances						2005-2006 Investigation Wells with One or More PRG Exceedances					
			Total	cVOCs	BTEX	SVOCs	Metals	Pesticides	Total	cVOCs	BTEX	SVOCs	Metals	Pesticides
B&M Railroad Landfill	MW-01A, MW-01C, MW-213S, MW-213D, MW-214S, OW-35, OW-50	7	5	1 MW-213D	0 No Exceedances	0 No Exceedances	5 MW-213S, MW-213D, MW-214S, OW-35, OW-50	0 No Exceedances	4	0 No Exceedances	0 No Exceedances	0 No Exceedances	4 MW-213S, MW-214S, OW-35, OW-50	0 No Exceedances
RSI Landfill	MW-210S, MW-211S, MW-211D, MW-212D, OW-02, OW-25, OW-26	7	7	0 No Exceedances	0 No Exceedances	0 No Exceedances	7 MW-210S, MW-211S, MW-211D, MW-212D, OW-02, OW-25, OW-26	0 No Exceedances	7	0 No Exceedances	0 No Exceedances	0 No Exceedances	7 MW-210S, MW-211S, MW-211D, MW-212D, OW-02, OW-25, OW-26	0 No Exceedances
Asbestos Landfill	OW-07, OW-08, OW-25, OW-26	4	4	1 OW-07	1 OW-08	0 No Exceedances	4 OW-07, OW-08, OW-25, OW-26	0 No Exceedances	4	1 OW-08	1 OW-08	0 No Exceedances	4 OW-07, OW-08, OW-25, OW-26	0 No Exceedances
Contaminated Soils Area	MW-208S, MW-208D, OW-20, OW-35, OW-38	5	5	0 No Exceedances	0 No Exceedances	0 No Exceedances	5 MW-208S, MW-208D, OW-20, OW-35, OW-38	0 No Exceedances	5	2 OW-20, OW-38	0 No Exceedances	0 No Exceedances	5 MW-208S, MW-208D, OW-20, OW-35, OW-38	0 No Exceedances
B&M Locomotive Shop Disposal Areas (A&B)	MW-204S, MW-205S, MW-206S, MW-206D	4	2	0 No Exceedances	0 No Exceedances	0 No Exceedances	2 MW-204S, MW-205S	0 No Exceedances	3	0 No Exceedances	0 No Exceedances	0 No Exceedances	3 MW-204S, MW-205S, MW-206S	0 No Exceedances
Old B&M Oil/Sludge Recycling Area	MW-202S, MW-202D, MW-203S, MW-203D, OW-38	5	3	0 No Exceedances	0 No Exceedances	0 No Exceedances	3 MW-203D, MW-203S, OW-38	0 No Exceedances	3	2 MW-202S, OW-38	0 No Exceedances	0 No Exceedances	3 MW-202S, MW-203S, OW-38	0 No Exceedances
Asbestos Lagoons	MW-208S, MW-208D, OW-10, OW-12, OW-20	5	5	0 No Exceedances	0 No Exceedances	0 No Exceedances	5 MW-208S, MW-208D, OW-10, OW-12, OW-20	0 No Exceedances	5	1 OW-20	0 No Exceedances	0 No Exceedances	5 MW-208S, MW-208D, OW-10, OW-12, OW-20	0 No Exceedances
TOTAL ¹		37	31	2	1	0	31	0	31	6	1	0	31	0

TABLE 2-10c. COMPARISON OF HISTORICAL PRG EXCEEDANCES IN GROUNDWATER BY AREA OF CONCERN - BEDROCK

Bedrock Wells Sampled During Both 1995 Remedial Investigation and 2005/06 Monitoring Rounds

	Wells Sampled	# Wells Sampled	1995 Remedial Investigation Wells with One or More PRG Exceedances							2005-2006 Investigation Wells with One or More PRG Exceedances						
			Total	cVOCs	BTEX	SVOCs	Metals	Pesticides		Total	cVOCs	BTEX	SVOCs	Metals	Pesticides	
B&M Railroad Landfill	MW-213B, MW-215B, OW-49	3	2	2 MW-213B, OW-49	0 No Exceedances	0 No Exceedances	1 OW-49	0 No Exceedances		2	2 MW-213B, OW-49	0 No Exceedances	0 No Exceedances	2 MW-213B, OW-49	0 No Exceedances	
RSI Landfill	MW-207B, MW-212B, OW-01	3	3	2 MW-207B, OW-01	0 No Exceedances	0 No Exceedances	1 MW-212B	0 No Exceedances		2	1 MW-207B	0 No Exceedances	0 No Exceedances	2 MW-207B, MW-212B	0 No Exceedances	
Asbestos Landfill	MW-207B	1	1	1 MW-207B	0 No Exceedances	0 No Exceedances	0 No Exceedances	0 No Exceedances		1	1 MW-207B	0 No Exceedances	0 No Exceedances	1 MW-207B	0 No Exceedances	
Contaminated Soils Area	MW-208B, MW-209B, OW-37	3	3	1 MW-209B	0 No Exceedances	0 No Exceedances	3 MW-208B, MW-209B, OW-37	0 No Exceedances		2	1 MW-209B	0 No Exceedances	0 No Exceedances	2 MW-209B, OW-37	0 No Exceedances	
B&M Locomotive Shop Disposal Areas (A&B)	No bedrock wells sampled for this AOC during both events	--	--	--	--	--	--	--		--	--	--	--	--	--	
Old B&M Oil/Sludge Recycling Area	MW-202B, MW-203B, OW-37	3	1	0 No Exceedances	0 No Exceedances	0 No Exceedances	1 OW-37	0 No Exceedances		1	0 No Exceedances	0 No Exceedances	0 No Exceedances	1 OW-37	0 No Exceedances	
Asbestos Lagoons	MW-208B, MW-209B, OW-09	3	3	1 MW-209B	0 No Exceedances	0 No Exceedances	3 MW-208B, MW-209B, OW-09	0 No Exceedances		2	1 MW-209B	0 No Exceedances	0 No Exceedances	2 MW-209B, OW-09	0 No Exceedances	
TOTAL ¹		16	13	7	0	0	9	0		10	6	0	0	10	0	

Notes

1. Note that some wells may be associated with multiple Areas of Concern (AOCs), so the totals may reflect that duplication.

cVOCs - Chlorinated volatile organic compounds

BTEX - Benzene, toluene, ethylbenzene, and xylene

SVOCs - Semivolatile organic compounds

PRG - Preliminary remediation goal

TABLE 2-11. NOTABLE DETECTIONS AND OBSERVATIONS OF WINTER 2005-2006 GROUNDWATER MONITORING ROUND

Well ID	Original Selection Rationale (based on historical monitoring data)	Notable Detections and Observations of Winter 2005-2006 Monitoring Round
RSI Landfill		
MW-207B	Location upgradient of Asbestos Landfill; historical detections of 1,1,1-TCA and 1,2-DCA	<ul style="list-style-type: none"> • Miscellaneous VOCs detected • TCE and PCE above PRGs; • 1,1,1-TCA detected at 2.3 ug/L, which is just below the historical detection of 3 ug/L; • 1,2-DCA detected at 2.6 ug/L which is less than half of historical results; • Mn above PRG • 1,4-dioxane at 1.3 ug/L
MW-210S	Metal concentrations higher than most other site locations	<ul style="list-style-type: none"> • Similar to historical results • As and Mn above PRGs
MW-211D	Metal concentrations higher than most other site locations	<ul style="list-style-type: none"> • Similar to historical results • As and Mn above PRGs
MW-211S	Pesticides, Mn, and As concentrations higher than most other site locations	<ul style="list-style-type: none"> • No organics detected • As and Mn reduced in magnitude compared to historical results
MW-212B	Mn detected above the PRG	<ul style="list-style-type: none"> • As and Mn above PRGs
MW-212D	1,1,2,2-Tetrachloroethane and manganese detected above the PRGs	<ul style="list-style-type: none"> • 1,1,2,2-Tetrachloroethane now ND • As and Mn above PRGs
OW-01	TCE detected at the MCL/PRG (5 ug/L)	<ul style="list-style-type: none"> • TCE now below PRG (1.5 ug/L) • Detections of 1,1-DCA (1.4 ug/L) and 1,2-DCA (0.74 ug/L) – Below PRG
OW-02	Mn detected above the PRG	<ul style="list-style-type: none"> • Mn detected at the same magnitude; • As above PRG
OW-25	Tl and Mn detected above the PRGs	<ul style="list-style-type: none"> • Miscellaneous VOCs detected • TCE and PCE just below PRGs (3.2 and 4.4 ug/L, respectively) • Mn above PRG; • Tl was ND, but the DL was elevated (5 ug/L) above the PRG of 2 ug/L
OW-26	Pesticides detected	<ul style="list-style-type: none"> • Pesticides now ND • As above PRG

B&M Locomotive Shop Disposal Areas (A&B)		
MW-204S	1,1,2,2-Tetrachloroethane and Mn detected above the PRGs	<ul style="list-style-type: none"> • Acenaphthene only organic detected; • Mn detected well above the PRG (22400 ug/L)
MW-205S	Check the surficial aquifer in the Locomotive Shop Disposal Areas	<ul style="list-style-type: none"> • Acenaphthene and phenanthrene only organics detected • Mn above PRG
MW-206D	Check the deep aquifer in the Locomotive Shop Disposal Areas	<ul style="list-style-type: none"> • 1,2-Dichloropropane and MTBE only organics detected • No PRG exceedances
MW-206S	Check the surficial aquifer in the Locomotive Shop Disposal Areas	<ul style="list-style-type: none"> • MTBE only organic detected • Mn above PRG

TABLE 2-11. NOTABLE DETECTIONS AND OBSERVATIONS OF WINTER 2005-2006 GROUNDWATER MONITORING ROUND

Well ID	Original Selection Rationale (based on historical monitoring data)	Notable Detections and Observations of Winter 2005-2006 Monitoring Round
Contaminated Soils Area (CSA)		
OW-20	Pesticides detected and Mn detected above the PRG	<ul style="list-style-type: none"> • Miscellaneous VOCs detected • TCE and PCE above PRGs (7 and 39 ug/L, respectively) • Pesticides now ND • As and Mn above PRGs
OW-35	Pesticides near the Contaminated Soils Area detected here	<ul style="list-style-type: none"> • No organics detected • Mn at 327 ug/L – previously 306 ug/L (similar to historical)
OW-37	Mn detected above the PRG	<ul style="list-style-type: none"> • Miscellaneous organics detected • Mn similar to historical results
OW-38	A downgradient location from the Oil/Sludge Recycling Area (which had detections of 1,1,1-TCA); Mn detected above the PRG	<ul style="list-style-type: none"> • 1,4-Dioxane was ND • VOC detections were higher than most other locations • PCE above PRG (14 ug/L) • Carbon tetrachloride at 37 ug/L • Mn similar to historical results
MW-208B	BEHP detected above the PRG	<ul style="list-style-type: none"> • BEHP now below PRG • Mn now below PRG
MW-208D	BEHP detected above the PRG	<ul style="list-style-type: none"> • BEHP now below PRG • Mn above PRG
MW-208S	As and Mn detected above the PRGs	<ul style="list-style-type: none"> • As and Mn detected at magnitudes similar to historical results
MW-209B	1,2-DCA and Mn detected above PRGs	<ul style="list-style-type: none"> • Both 1,2-DCA and Mn still above PRGs, with 1,2-DCA approximately half of historical results
MW-304S	Fill a data gap at the Contaminated Soils Area	<ul style="list-style-type: none"> • PCE detected (0.085 ug/L) • delta-BHC detected (0.0054 ug/L)
MW-304D	Fill a data gap at the Contaminated Soils Area; sample for 1,4-dioxane in the deep overburden flow zone	<ul style="list-style-type: none"> • Bromochloromethane, PCE, and toluene detected (0.057, 0.34, and 0.46 ug/L, respectively) • 1,4-dioxane was ND
MW-304B	Fill a data gap at the Contaminated Soils Area	<ul style="list-style-type: none"> • 1,1-DCA (0.47 ug/L) and bromochloromethane (0.27 ug/L) detected • bis(2-chloroethyl)ether, butylbenzylphthalate, and naphthalene detected at less than 0.2 ug/L

TABLE 2-11. NOTABLE DETECTIONS AND OBSERVATIONS OF WINTER 2005-2006 GROUNDWATER MONITORING ROUND

Well ID	Original Selection Rationale (based on historical monitoring data)	Notable Detections and Observations of Winter 2005-2006 Monitoring Round
Asbestos Landfill		
MW-207B	Location upgradient of Asbestos Landfill; historical detections of 1,1,1-TCA and 1,2-DCA	<ul style="list-style-type: none"> • Miscellaneous VOCs detected • TCE and PCE above PRGs; • 1,1,1-TCA detected at 2.3 ug/L, which is just below the historical detection of 3 ug/L; • 1,2-DCA detected at 2.6 ug/L which is less than half of historical results; • Mn above PRG • 1,4-dioxane at 1.3 ug/L
MW-305S	Fill a data gap upgradient of the Asbestos Landfill; 1,1,1-TCA was previously detected in MW-207B	<ul style="list-style-type: none"> • Miscellaneous VOCs and SVOCs detected – all less than 2 ug/L • 4,4'-DDT and dieldrin detected • Mn above PRG • 1,4-dioxane was ND
MW-305D	Fill a data gap upgradient of the Asbestos Landfill; 1,1,1-TCA was previously detected in MW-207B	<ul style="list-style-type: none"> • Miscellaneous VOCs and SVOCs detected – all less than 5 ug/L • 1,4-dioxane at 1.7 ug/L • 1,2-DCA close to PRG (4.8 ug/L)
MW-306S	Fill a data gap upgradient of the Asbestos Landfill	<ul style="list-style-type: none"> • Miscellaneous VOCs and SVOCs detected, including phenols, phthalates, and PAHs – none above 1 ug/L
MW-307S	Fill a data gap at the Asbestos Landfill	<ul style="list-style-type: none"> • Benzene detected above PRG (6.6 ug/L) • Many VOCs detected, including vinyl chloride (0.66 ug/L) • Miscellaneous SVOCs detected – all below 1.5 ug/L • Mn above PRG
MW-307D	Fill a data gap at the Asbestos Landfill	<ul style="list-style-type: none"> • Many VOCs detected • 1,2-DCA above PRG (11 ug/L)
MW-307B	Fill a data gap at the Asbestos Landfill	<ul style="list-style-type: none"> • Many VOCs detected • 1,2-DCA above PRG (23 ug/L) • As above PRG
MW-308B	Check the bedrock aquifer below the Asbestos Landfill	<ul style="list-style-type: none"> • Many VOCs detected • 1,2-DCA above PRG (8.5 ug/L) • TCE well above PRG (75 ug/L) • Vinyl chloride detected (0.74 ug/L) • 1,4-dioxane detected (2 ug/L)
OW-07	The second highest PCB concentration detected, as well as TCE above the PRG	<ul style="list-style-type: none"> • PCBs now non-detect (ND) • TCE reduced from 21 ug/L to 4.6 ug/L • 1,1-DCA (0.34 ug/L); chloromethane (1.6 ug/L); and trans-1,2-DCE (0.58 ug/L) • Mn detected above PRG at similar magnitude to historical results
OW-08	Benzene detected, as well as pesticides	<ul style="list-style-type: none"> • Benzene still detected above PRG, but at 59 ug/L rather than above 300 ug/L • 1,1,1-TCA, 1,1-DCA, and chlorobenzene were previously not detected and are now present at 22, 38, and 46 ug/L, respectively • Other miscellaneous VOCs, including BTEX compounds, detected at low concentrations • Phenol was the only SVOC detected (5.7 ug/L) • Pesticides were ND • Metals detected at similar magnitude to historical results (Mn and As above PRG)

TABLE 2-11. NOTABLE DETECTIONS AND OBSERVATIONS OF WINTER 2005-2006 GROUNDWATER MONITORING ROUND

Well ID	Original Selection Rationale (based on historical monitoring data)	Notable Detections and Observations of Winter 2005-2006 Monitoring Round
OW-25	Tl and Mn detected above the PRGs	<ul style="list-style-type: none"> Miscellaneous VOCs detected TCE and PCE just below PRGs (3.2 and 4.4 ug/L, respectively) Mn above PRG; Tl was ND, but the DL was elevated (5 ug/L) above the PRG of 2 ug/L
OW-26	Pesticides detected	<ul style="list-style-type: none"> Pesticides now ND As above PRG

B&M Railroad Landfill		
MW-01	Check the most downgradient wells	<ul style="list-style-type: none"> Two PAHs detected at 0.012 ug/L, no PRG exceedances No historical results
MW-01A	Check the most downgradient wells; sample one deep overburden well for 1,4-dioxane	<ul style="list-style-type: none"> No PRG exceedances; 1,4-dioxane was ND
MW-01B	Check the most downgradient wells	<ul style="list-style-type: none"> Two PAHs detected; no PRG exceedances No historical results - Similar to MW-01
MW-01C	Check the most downgradient wells; sample the shallow overburden well for 1,4-dioxane	<ul style="list-style-type: none"> No organics detected (including 1,4-dioxane) No PRG exceedances
MW-213B	Multiple chlorinated VOCs detected above PRGs	<ul style="list-style-type: none"> 1,1-DCE and 1,2-DCA now below PRGs TCE still above PRG (16 ug/L), but trending downwards Metals below PRGs
MW-213D	Chlorinated VOCs and Mn detected above PRGs	<ul style="list-style-type: none"> 1,1-DCE now ND TCE now below PRG (4.8 ug/L) – down significantly Mn now below PRG
MW-213S	PCBs and pesticides detected here	<ul style="list-style-type: none"> A few pesticides detected PCBs now ND Mn above PRG
MW-214S	The highest site PCB concentrations were detected here, along with exceedances of PRGs by pesticides, Mn, and As	<ul style="list-style-type: none"> Pesticides/PCBs now ND As and Mn still above PRGs
MW-215B	BEHP detected above the PRG	<ul style="list-style-type: none"> BEHP now ND
OW-35	Pesticides near the Contaminated Soils Area detected here	<ul style="list-style-type: none"> No organics detected Mn at 327 ug/L – previously 306 ug/L (similar to historical)
OW-49	Close to off-site; downgradient of B&M Railroad Landfill	<ul style="list-style-type: none"> 1,2-DCA at PRG (5 ug/L; was previously above PRG) TCE still above PRG (7.8 ug/L), but a lot lower than historical values (22-25 ug/L) Mn still above PRG (516 ug/L), but now half of historical results
OW-50	Close to off-site; downgradient of B&M Railroad Landfill; check for 1,4-dioxane in a downgradient location	<ul style="list-style-type: none"> 1,4-Dioxane detected (0.59 ug/L) below state MCL Mn still moderate (1350 ug/L)
OW-51	Close to off-site; downgradient of B&M Railroad Landfill	<ul style="list-style-type: none"> As and Mn above PRGs No historical results
PZ-115	Sample LNAPL	<ul style="list-style-type: none"> LNAPL determined to be No. 6 Fuel Oil

TABLE 2-11. NOTABLE DETECTIONS AND OBSERVATIONS OF WINTER 2005-2006 GROUNDWATER MONITORING ROUND

Well ID	Original Selection Rationale (based on historical monitoring data)	Notable Detections and Observations of Winter 2005-2006 Monitoring Round
Old B&M Oil/Sludge Recycling Area		
MW-202B	Check to see if contaminants migrated out of Oil/Sludge Recycling Area	<ul style="list-style-type: none"> No notable detections
MW-202D	Check to see if contaminants migrated out of Oil/Sludge Recycling Area	<ul style="list-style-type: none"> No notable detections
MW-202S	Check to see if contaminants migrated out of Oil/Sludge Recycling Area; check surficial aquifer for pesticide detections	<ul style="list-style-type: none"> High detection of carbon tetrachloride (120 ug/L) Miscellaneous VOCs and SVOCs detected Pesticides were ND As above PRG
MW-203B	Check to see if contaminants migrated out of Oil/Sludge Recycling Area	<ul style="list-style-type: none"> No notable detections
MW-203D	1,1,1-TCA detected	<ul style="list-style-type: none"> 1,1,1-TCA still detected, but lower (0.16 ug/L); No PRG exceedances 1,4-dioxane at 2.9 ug/L
MW-203S	1,1,1-TCA detected in MW-203D; check surficial aquifer in the area downgradient of the Oil/Sludge Recycling Area	<ul style="list-style-type: none"> Mn above PRG 1,4-dioxane was ND
MW-301S	Check the surficial aquifer in the Oil/Sludge Recycling Area for PCBs/pesticides; 1,1,1-TCA detected in the historical MW-201S location	<ul style="list-style-type: none"> MTBE detected (3.4 ug/L) As and Mn above PRGs 1,4-dioxane was ND
MW-301D	1,1,1-TCA detected in the historical MW-201S location	<ul style="list-style-type: none"> MTBE detected (0.21 ug/L) Toluene detected (0.13 ug/L)
MW-301B	Replace destroyed wells upgradient of the Oil/Sludge Recycling Area	<ul style="list-style-type: none"> Toluene detected at 0.2 ug/L
MW-302S	Check the surficial aquifer in the area downgradient of the Oil/Sludge Recycling Area; screen at the water table to look for LNAPL	<ul style="list-style-type: none"> No organics detected No notable metal detections
MW-303S	LNAPL was historically found in destroyed piezometer P-12. Check the surficial aquifer in this area and screen at the water table to look for LNAPL; likely location for LNAPL sample	<ul style="list-style-type: none"> Carbon tetrachloride detected (0.39 ug/L) As and Mn above PRGs LNAPL not detected
OW-37	Mn detected above the PRG	<ul style="list-style-type: none"> Miscellaneous organics detected Mn similar to historical results
OW-38	A downgradient location from the Oil/Sludge Recycling Area (which had detections of 1,1,1-TCA); Mn detected above the PRG	<ul style="list-style-type: none"> 1,4-Dioxane was ND VOC detections were higher than most other locations PCE above PRG (14 ug/L) Carbon tetrachloride at 37 ug/L Mn similar to historical results

TABLE 2-11. NOTABLE DETECTIONS AND OBSERVATIONS OF WINTER 2005-2006 GROUNDWATER MONITORING ROUND

Well ID	Original Selection Rationale (based on historical monitoring data)	Notable Detections and Observations of Winter 2005-2006 Monitoring Round
Asbestos Lagoons		
MW-208B	BEHP detected above the PRG	<ul style="list-style-type: none"> • BEHP now below PRG • Mn now below PRG
MW-208D	BEHP detected above the PRG	<ul style="list-style-type: none"> • BEHP now below PRG • Mn above PRG
MW-208S	As and Mn detected above the PRGs	<ul style="list-style-type: none"> • As and Mn detected at magnitudes similar to historical results
MW-209B	1,2-DCA and Mn detected above PRGs	<ul style="list-style-type: none"> • Both 1,2-DCA and Mn still above PRGs, with 1,2-DCA approximately half of historical results
OW-09	The highest concentration of PCBs detected here	<ul style="list-style-type: none"> • VOCs previously detected (1,1-DCA, 1,2-dichlorobenzene, and 1,2-DCA) decreased in concentration; • New VOCs detected all at less than 5 ug/L, with most below 1 ug/L • One pesticide (alpha-chlordane) detected (0.0051 ug/L) • PCBs were ND • High Mn (22600 ug/L)
OW-10	Mn detected above the PRG	<ul style="list-style-type: none"> • Miscellaneous VOCs and SVOCs detected – none above PRGs • Metals at similar magnitude to historical results
OW-12	1,1,2,2-Tetrachloroethane detected above the PRG	<ul style="list-style-type: none"> • 1,1,2,2-Tetrachloroethane now ND • Miscellaneous VOCs, including BTEX compounds, detected at low concentrations (< 2 ug/L) • As above PRG • Mn now below PRG •
OW-20	Pesticides detected and Mn detected above the PRG	<ul style="list-style-type: none"> • Miscellaneous VOCs detected • TCE and PCE above PRGs (7 and 39 ug/L, respectively) • Pesticides now ND • As and Mn above PRGs

Notes

1,1,1-TCA – 1,1,1-Trichloroethane

1,1-DCE – 1,1-Dichloroethene

1,2-DCA – 1,2-Dichloroethane

As – Arsenic

BEHP – Bis(2-ethylhexyl)phthalate

LNAPL – Light non-aqueous phase liquid

MCL – Maximum Contaminant Limit

Mn – Manganese

ND – Non-detect

PAHs – Polynuclear Aromatic Hydrocarbons

PCBs – Polychlorinated Biphenyls

PCE – Tetrachloroethene

PRG – Preliminary Remediation Goal

TCE – Trichloroethene

Tl – Thallium

SVOCs – Semivolatile Organic Compounds

VOCs – Volatile Organic Compounds

TABLE 2-12. TECHNOLOGY & PROCESS OPTION SCREENING - GROUNDWATER

<u>GENERAL RESPONSE ACTIONS</u>	<u>REMEDIAL TECHNOLOGY</u>	<u>PROCESS OPTIONS</u>	<u>TECHNOLOGY DESCRIPTION</u>	<u>SCREENING</u>
NO ACTION	NONE	NONE	No remedial or response action taken within the site.	<u>POTENTIALLY APPLICABLE:</u> Required as a baseline evaluation by the NCP.
INSTITUTIONAL ACTIONS	ACCESS RESTRICTIONS	INSTITUTIONAL CONTROLS	Groundwater below property cannot be used as a potable water supply source; restrictions may include modifications to deeds, zoning, and ordinances; typically combined with alternate water supply technologies. Also restrictions to protect components of the remedy.	<u>POTENTIALLY APPLICABLE:</u> Effective in mitigating site risk by eliminating risk pathway to receptors and protecting components of the remedy; implementation will require close cooperation between Local, State and Federal officials.
		FENCING & SECURITY MEASURES	Placement of fencing, security alarms, etc. around the site boundary to limit public exposure to groundwater.	<u>SCREENED OUT:</u> Not effective in mitigating on-site risk to human receptors.
	MONITORING	GROUNDWATER MONITORING	Analytical testing of residential and site monitoring wells to determine changes in groundwater quality.	<u>POTENTIALLY APPLICABLE:</u> Effective in confirming migration of contaminants, success of remedy, and water quality.
	ALTERNATE WATER SUPPLY CONTINGENCY	MUNICIPAL WATER SUPPLY	Connect residents to public water company supply if private wells contain contamination above regulatory levels.	<u>SCREENED OUT:</u> Limited effectiveness; off-site residents primarily supplied by town surface water supply.
		TREATMENT: POINT-OF-USE	Treatment systems installed at the individual water user (residential or commercial) if groundwater concentrations exceed criteria.	<u>SCREENED OUT:</u> Limited effectiveness; off-site residents primarily supplied by town surface water supply.
	EMINENT DOMAIN	PROPERTY ACQUISITION	Acquisition of private property next to site w/payment of compensation to the owner.	<u>SCREENED OUT:</u> Other institutional actions (e.g., institutional controls) will be more appropriate to implement.

KEY: Technology / Process Option screened from further evaluation.

TABLE 2-13. TECHNOLOGY & PROCESS OPTION SCREENING - SEDIMENT

<u>GENERAL RESPONSE ACTIONS</u>	<u>REMEDIAL TECHNOLOGY</u>	<u>PROCESS OPTIONS</u>	<u>TECHNOLOGY DESCRIPTION</u>	<u>SCREENING</u>
NO ACTION	NONE	NONE	No remedial or response action taken within the Site.	<u>POTENTIALLY APPLICABLE:</u> Required as a baseline evaluation by the NCP.
INSTITUTIONAL ACTIONS	MONITORING	SEDIMENT MONITORING	Analytical testing of residential and site samples to determine changes in sediment's quality.	<u>POTENTIALLY APPLICABLE:</u> Effective in confirming migration of contaminants, success of remedy and sediment quality.
SOURCE CONTROL	HORIZONTAL CONTAINMENT	NATURAL CAP	Cover area of contaminated sediments with clean local sediments to create a barrier between contamination and receptors.	<u>POTENTIALLY APPLICABLE:</u> Effective in reducing receptor contact with contaminated sediments in slow-moving water.
		ENGINEERED CAP	Cover area of contaminated sediments with materials designed to create a barrier between contamination and receptors.	<u>POTENTIALLY APPLICABLE:</u> Effective in reducing receptor contact with contaminated sediments in fast-moving water.
	VERTICAL CONTAINMENT	SLURRY WALL	Low permeability subsurface wall consisting of soil or cement and bentonite mixture encircling contaminated sediments.	<u>SCREENED OUT:</u> Although effective in reducing lateral migration of contaminants, receptor habitat is not improved by this technology.
		SHEET PILING	Low permeability subsurface wall consisting of sheet piling encircling contaminated sediments.	<u>SCREENED OUT:</u> Although effective in reducing lateral migration of contaminants, receptor habitat is not improved by this technology.
		CAST-IN-PLACE CONCRETE WALL	Concrete wall constructed in a temporary sheet pile cofferdam.	<u>SCREENED OUT:</u> Although effective in reducing lateral migration of contaminants, receptor habitat is not improved by this technology.
		VERTICAL GEOMEMBRANE	Low permeability subsurface wall consisting of vertical geomembrane encircling contaminated sediments.	<u>SCREENED OUT:</u> Although effective in reducing lateral migration of contaminants, receptor habitat is not improved by this technology.
		PRESSURE GROUTING	Low permeability subsurface wall consisting of adjacent grout injections encircling contaminated sediments.	<u>SCREENED OUT:</u> Although effective in reducing lateral migration of contaminants, receptor habitat is not improved by this technology.

TABLE 2-13. TECHNOLOGY & PROCESS OPTION SCREENING - SEDIMENT

<u>GENERAL RESPONSE ACTIONS</u>	<u>REMEDIAL TECHNOLOGY</u>	<u>PROCESS OPTIONS</u>	<u>TECHNOLOGY DESCRIPTION</u>	<u>SCREENING</u>
SOURCE CONTROL (continued)	EXCAVATION	DREDGING	Removal of sediments utilizing equipment which originates at the water surface. Sediments are either pumped (hydraulic dredging) or extracted mechanically (mechanical dredging).	<u>POTENTIALLY APPLICABLE:</u> Effective removal technology for water bodies which are too deep to allow cost-effective water diversion/dewatering for dry excavation.
		DRY EXCAVATION	Removal of sediments by diverting/dewatering surface water in area of excavation.	<u>POTENTIALLY APPLICABLE:</u> Effective removal technology for shallow water bodies with contamination close to shore.
	ON-SITE DISPOSAL	SINGLE OR DOUBLE BARRIER CAP	Excavated contaminated sediments are placed under on-site protective cap.	<u>POTENTIALLY APPLICABLE:</u> A cost-effective option if capping technologies will be used at the site for other media of concern.
TREATMENT: OFF-SITE	OFF-SITE TREATMENT/ DISPOSAL	RCRA SUBTITLE C/ SUBTITLE D LANDFILL FACILITY	Transport contaminated sediments for disposal in RCRA Subtitle C or Subtitle D landfill.	<u>POTENTIALLY APPLICABLE:</u> Cost-effective for small volumes of sediment.
		RCRA TSD FACILITY	Utilize outside licensed RCRA treatment, storage and disposal (TSD) facility for ultimate disposition of contaminated sediments.	<u>SCREENED OUT:</u> Other disposal options are more cost-effective.
		SOLIDIFICATION/ STABILIZATION FACILITY	Contaminants are physically bound or enclosed within a stabilized mass (solidification, i.e. asphalt batch processing), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization).	<u>SCREENED OUT:</u> While reuse of material as asphalt would be preferable to other options, this technology does not work well with sediments due to fine grain materials.

TABLE 2-13. TECHNOLOGY & PROCESS OPTION SCREENING - SEDIMENT

<u>GENERAL RESPONSE ACTIONS</u>	<u>REMEDIAL TECHNOLOGY</u>	<u>PROCESS OPTIONS</u>	<u>TECHNOLOGY DESCRIPTION</u>	<u>SCREENING</u>
TREATMENT: IN-SITU	PHYSICAL PROCESSES	ELECTROACOUSTIC SOIL DECONTAMINATION	Removes heavy metals from sediments through direct current electrical and acoustic fields. Direct current facilitates liquid transport through sediments. The technology consists of electrodes, an anode and a cathode, and an acoustic source.	<u>SCREENED OUT:</u> Limited effectiveness; technology designed for removal of inorganic contaminants, but not for site organic COCs which constitute part of site risk.
		ELECTROKINETIC PROCESSES	Application of a low current to electrodes in the subsurface in order to mobilize contaminants in two ways: (1) in the form of charged species (electrolysis); or (2) by causing an imbalance of charge bonds in clayey material, which results in clay compaction and chemical desorption (electro-osmosis).	<u>SCREENED OUT:</u> Limited effectiveness; technology designed for removal of inorganic contaminants, but has not been fully proven as cost-effective for site organic COCs which constitute part of site risk.
		HYDRAULIC & PNEUMATIC FRACTURING	Injection of pressurized water through wells cracks low permeability and over-consolidated sediments. Cracks are filled with porous media that serve as substrates for bioremediation or to improve pumping efficiency.	<u>SCREENED OUT:</u> Technologies which would use this process option to enhance treatment effectiveness have been screened out.
	BIOLOGICAL PROCESSES	MONITORED NATURAL RECOVERY	Naturally occurring processes in the environment that reduce the concentration of COCs in the sediments.	<u>POTENTIALLY APPLICABLE:</u> Effective in reduction of site COCs over time. This option is cost-effective and easily implemented.
		ENHANCED BIODEGRADATION	Enhancement of natural microbial breakdown by addition of nutrients, co-substrates and oxygen sources via injection wells.	<u>SCREENED OUT:</u> Control of materials added below surface water may cause implementation difficulties. Not cost-effective to divert surface water for application of nutrients, etc. in comparison to other process options.
		PHYTO-REMEDICATION	Removal of contaminants by plant roots from shallow soil and sediment through the processes of phytoaccumulation, phytodegradation and phytostabilization.	<u>SCREENED OUT:</u> The diverse site COCs would require multiple types of plants and a complex implementation process. Furthermore, effectiveness during winter months would likely be limited.

TABLE 2-13. TECHNOLOGY & PROCESS OPTION SCREENING - SEDIMENT

<u>GENERAL RESPONSE ACTIONS</u>	<u>REMEDIAL TECHNOLOGY</u>	<u>PROCESS OPTIONS</u>	<u>TECHNOLOGY DESCRIPTION</u>	<u>SCREENING</u>
TREATMENT: IN-SITU (continued)	CHEMICAL PROCESSES	SOLIDIFICATION & STABILIZATION	Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization).	<u>SCREENED OUT:</u> Control of materials added below surface water may cause implementation difficulties. Not cost-effective, when compared to other process options, to divert surface water for implementation of technology.
		CHEMICAL REDUCTION/OXIDATION	Reduction/oxidation chemically converts hazardous contaminants to non-hazardous or less toxic compounds that are more stable, less mobile, and/or inert.	<u>SCREENED OUT:</u> Control of materials added below surface water may cause implementation difficulties. Not cost-effective, when compared to other process options, to divert surface water for application of chemicals.
	THERMAL PROCESSES	THERMAL DESORPTION	Heating of sediments by method such as radio frequency heating to increase the volatilization rate of contaminants and facilitate collection.	<u>SCREENED OUT:</u> Not cost-effective for wet sediments; not effective on inorganic contaminants.
		VITRIFICATION	Heating of sediments to a molten state by electrodes which destroys organics and forms a glassy matrix as sediments cool.	<u>SCREENED OUT:</u> Not cost-effective for wet sediments.
	PHYSICAL PROCESSES	ELECTROKINETIC PROCESSES	Removal of contaminanants through application of low-intensity direct current into the sediment to mobilize charged species (ions and water) towards the electrodes.	<u>SCREENED OUT:</u> Effective in removal of inorganic site COCs, but at a much slower rate than other ex-situ process options.
TREATMENT: ON-SITE	CHEMICAL PROCESSES	CHEMICAL EXTRACTION	Waste contaminated sediment and extractant are mixed in an extractor, dissolving the contaminants. The extracted solution is then placed in a separator, where the contaminants and extractant are separated for further treatment.	<u>POTENTIALLY APPLICABLE:</u> Effective in removal of both organic and inorganic site COCs.
		SOLIDIFICATION & STABILIZATION	Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization).	<u>SCREENED OUT:</u> While reuse of material as asphalt would be preferable to other options, this technology does not work well with sediments due to fine grain materials.

TABLE 2-13. TECHNOLOGY & PROCESS OPTION SCREENING - SEDIMENT

<u>GENERAL RESPONSE ACTIONS</u>	<u>REMEDIAL TECHNOLOGY</u>	<u>PROCESS OPTIONS</u>	<u>TECHNOLOGY DESCRIPTION</u>	<u>SCREENING</u>
TREATMENT: ON-SITE (continued)	CHEMICAL PROCESSES (continued)	CHEMICAL REDUCTION/OXIDATION	Reduction/oxidation chemically converts hazardous contaminants to non-hazardous or less toxic compounds that are more stable, less mobile, and/or inert.	<u>SCREENED OUT:</u> Other treatment technologies are more cost-effective with equivalent mitigation of risks for site COCs.
		DEHALOGENATION	Reagents are added to sediments contaminated with halogenated organics. The dehalogenation process is achieved by either the replacement of the halogen molecules or the decomposition and partial volatilization of the contaminants.	<u>SCREENED OUT:</u> Not effective in removing the primary site COCs; technology is primarily used for chlorinated compounds.
		SOIL WASHING	Contaminants sorbed onto fine sediment particles are separated from bulk sediment in an aqueous-based system on the basis of particle size. The wash water may be augmented with a basic leaching agent, surfactant, pH adjustment, or chelating agent to help remove organics and heavy metals.	<u>POTENTIALLY APPLICABLE:</u> Effective in removal of both organic and inorganic site COCs. Wash water treatment and/or disposal is necessary.
	BIOLOGICAL PROCESSES	SLURRY PHASE BIOLOGICAL TREATMENT	An aqueous slurry is created by combining soil, sediment, or sludge with water and other additives. The slurry is mixed to keep solids suspended and microorganisms in contact with the sediment contaminants. Upon completion of the process, the slurry is dewatered and the treated sediment is disposed of.	<u>SCREENED OUT:</u> Not effective in removing the primary site COCs; technology is primarily used for fuels and VOCs.
		COMPOSTING	Contaminated sediment is excavated and mixed with bulking agents and organic amendments such as wood chips, hay, manure, and vegetative (e.g., potato) wastes. Proper amendment selection ensures adequate porosity and provides a balance of carbon and nitrogen leading to degradation of contaminants to non-toxic products.	<u>SCREENED OUT:</u> Not effective in removing the primary site COCs; technology is primarily used for fuels and VOCs.
		BIOPILES	Excavated sediments are mixed with amendments and placed in aboveground enclosures. It is an aerated static pile composting process in which compost is formed into piles and aerated with blowers or vacuum pumps.	<u>SCREENED OUT:</u> Not effective in removing the primary site COCs; technology is primarily used for fuels and VOCs.

TABLE 2-13. TECHNOLOGY & PROCESS OPTION SCREENING - SEDIMENT

<u>GENERAL RESPONSE ACTIONS</u>	<u>REMEDIAL TECHNOLOGY</u>	<u>PROCESS OPTIONS</u>	<u>TECHNOLOGY DESCRIPTION</u>	<u>SCREENING</u>
TREATMENT: ON-SITE (continued)	BIOLOGICAL PROCESSES (continued)	FUNGAL BIODEGRADATION	Fungal biodegradation refers to the degradation of a wide variety of organopollutants by adding lignin-degrading or wood-rotting enzymes.	<u>SCREENED OUT:</u> Not effective in removing the primary site COCs; technology is primarily used for explosives.
		LAND TREATMENT	Treatment of contaminants through dynamic interactions of wastes with sediment, climate and biological activity. Wastes are tilled periodically to create aeration.	<u>SCREENED OUT:</u> Not effective in removing the primary site COCs; technology is primarily used for fuels and VOCs.
	THERMAL PROCESSES	PYROLYSIS	Removal of contaminants through induction of chemical decomposition in organic materials by heat in the absence of oxygen.	<u>SCREENED OUT:</u> Other treatment technologies are more cost-effective with equivalent mitigation of risks for site organic COCs.
		INCINERATION	High temperatures are used to combust (in the presence of oxygen) organic constituents in hazardous wastes.	<u>SCREENED OUT:</u> Other treatment technologies are more cost-effective with equivalent mitigation of risks for site organic COCs.
		THERMAL DESORPTION	Wastes are heated to volatilize water and organic contaminants. A carrier gas or vacuum system transports volatilized water and organics to the gas treatment system.	<u>SCREENED OUT:</u> Other treatment technologies are more cost-effective with equivalent mitigation of risks for site organic COCs.
		PYRO-METALLURGICAL EXTRACTION	Utilizes elevated temperature extraction and processing for removal of metals from contaminated sediments. Sediments are treated in a high-temperature furnace to remove volatile metals from the solid phase. Subsequent treatment steps may include metal recovery or immobilization.	<u>SCREENED OUT:</u> Not effective in removing the primary site COCs; technology is primarily used for metals such as Hg.

KEY: Technology / Process Option screened from further evaluation.

TABLE 3-1. COMPONENTS OF REMEDIAL ALTERNATIVES - GROUNDWATER

Alternative	Key Components
GW-1: No Action	<ul style="list-style-type: none">- No remedial action, except for five-year reviews; for comparison only
GW-2: Limited Action	<ul style="list-style-type: none">- Establish monitoring program, including monitoring well installation (include MNA parameters)- Implement Institutional Controls (ICs) to restrict groundwater use as a potable water supply within compliance boundary- Five-year site reviews to evaluate remedy

TABLE 3-2. COMPONENTS OF REMEDIAL ALTERNATIVES - SEDIMENT

Alternative	Key Components
SD-1: No Action	<ul style="list-style-type: none">- No remedial action, except for five-year reviews; for comparison only
SD-2: Monitored Natural Recovery (MNR)	<ul style="list-style-type: none">- Establish monitoring program for MNR- Implement storm water runoff controls- Five-year site reviews to evaluate remedy
SD-3: Source Control - In-situ capping	<ul style="list-style-type: none">- Site preparation for cap in B&M Pond- Temporary access roadways and erosion control- Cover contaminated sediments with either natural sediments or an engineered cap- Establish MNR monitoring program for areas/residuals outside cap and in Unnamed Brook- Implement storm water runoff controls- Periodic monitoring and maintenance of cap- Wetland mitigation due to disturbance while constructing cap- Wetland/flood storage capacity replacement (excavation/disposal of nearby/surrounding sediments)- Five-year site reviews to evaluate remedy
SD-4: Source Control - Excavation (B&M Pond) with Disposal	<ul style="list-style-type: none">- Site preparation for excavation; create sediment staging pad- Temporary access roadways and erosion control; silt curtain to control migration of suspended particles- Excavate contaminated sediments using either dredging or dry excavation methods- After dewatering on the staging pad, transport sediment to disposal location (off-site or on-site)- Disposal of staging pad sump water- Establish MNR monitoring program for areas outside excavation and in Unnamed Brook- Implement storm water runoff controls- Wetland mitigation due to disturbance while excavating (includes replacement of excavated sediment)- Five-year site reviews to evaluate remedy

TABLE 3-2. COMPONENTS OF REMEDIAL ALTERNATIVES - SEDIMENT

Alternative	Key Components
SD-5: Source Control - Excavation with On-site Treatment - Chemical Extraction/Soil Washing	<ul style="list-style-type: none">- Site preparation for excavation; create sediment staging/treatment pad- Temporary access roadways and erosion control; silt curtain to control migration of suspended particles- Excavate contaminated sediments using either dredging or dry excavation methods- After dewatering on the staging pad, treat sediments and transport/place as fill in excavated areas- Dispose of wash water via groundwater injection- Disposal of staging pad sump water- Establish MNR monitoring program for areas outside excavation and in Unnamed Brook- Implement storm water runoff controls- Wetland mitigation due to disturbance while excavating- Five-year site reviews to evaluate remedy
SD-6: Source Control - Excavation (B&M Pond and Unnamed Brook) with Disposal	<ul style="list-style-type: none">- Site preparation for excavation; create sediment staging pad- Temporary access roadways and erosion control; silt curtain to control migration of suspended particles- Excavate contaminated sediments using either dredging or dry excavation methods- After dewatering on the staging pad, transport sediment to disposal location (off-site or on-site)- Disposal of staging pad sump water- Implement storm water runoff controls- Wetland mitigation due to disturbance while excavating (includes replacement of excavated sediment)

**TABLE 4-1. SCREENING OF REMEDIAL ALTERNATIVES - SEDIMENT
SD-1: NO ACTION**

Description: No remedial activities are included under this alternative.

	Effectiveness	Implementability	Cost
Advantages:	- None	- No action makes this the easiest alternative to implement	- No capital costs - No O&M costs
Disadvantages:	- Does not mitigate on-site risk due to ecological exposure	- Additional remedial actions may be required in the future	- Additional remedial actions may be required in the future - Periodic 5-year review costs

Conclusion: The No Action alternative is not protective of the environment. However, it is used as a baseline in comparison with other alternatives.

This alternative will be retained for detailed analysis.

**TABLE 4-2. SCREENING OF REMEDIAL ALTERNATIVES - SEDIMENT
SD-2: MONITORED NATURAL RECOVERY (MNR)**

Description: Under this alternative, a monitoring program for MNR would be established, under the assumption that contaminants show the potential for achieving PRGs in a reasonable length of time.

	Effectiveness	Implementability	Cost
Advantages:	<ul style="list-style-type: none"> - MNR is less detrimental to the wetlands than other active alternatives 	<ul style="list-style-type: none"> - The technology is easier to implement in the site wetlands than other technologies 	<ul style="list-style-type: none"> - No capital costs
Disadvantages:	<ul style="list-style-type: none"> - Long-term monitoring must be performed to determine effectiveness - There has not been any evidence that MNR will be effective for B&M Pond sediments 	<ul style="list-style-type: none"> - It will not be immediately determined if expected recovery processes will be fully successful - Additional monitoring of parameters such as sediment types, erosion, deposition, and other fate and transport properties, may be difficult in a wetland environment. 	<ul style="list-style-type: none"> - Moderate O&M costs - Additional remedies may be necessary - Periodic 5-year review costs

Conclusion: While MNR may be appropriate for some of the site contaminants and wetland areas, there has not been any evidence that MNR will be effective for B&M Pond sediments.

This alternative will not be retained for detailed analysis.

**TABLE 4-3. SCREENING OF REMEDIAL ALTERNATIVES - SEDIMENT
SD-3: SOURCE CONTROL - IN-SITU CAPPING**

Description: Under this alternative, contaminated sediments would be capped to limit exposure by ecological receptors. Areas outside of the cap, including Unnamed Brook, would be monitored as part of a MNR program.

Note that evaluation of effectiveness and implementability for this alternative is specific to B&M Pond. See Table 4-2 for evaluation of these parameters with respect to MNR at areas outside of the cap.

	Effectiveness	Implementability	Cost
Advantages:	<ul style="list-style-type: none"> - Limits exposure to sediments - Limits migration of any remaining contaminants 	<ul style="list-style-type: none"> - Capping is a proven technology 	<ul style="list-style-type: none"> - Low O&M costs
Disadvantages:	<ul style="list-style-type: none"> - Does not remove contaminants - Requirements to retain flood storage capacity may significantly increase the amount of damage to surrounding wetlands - Institutional controls may be necessary to protect cap integrity from impacts such as area utility work 	<ul style="list-style-type: none"> - Additional remedial actions may be required in the future - Capping in water bodies may be difficult to implement - Long-term monitoring and maintenance of the cap will be required - The amount of wetland mitigation (such as replacement) may be difficult to implement 	<ul style="list-style-type: none"> - Additional remedial actions may be required in the future - Periodic 5-year review costs - Moderate capital costs

Conclusion: While this alternative is protective of the environment, the wetland alterations required to construct the caps, restore/replace the wetlands lost by capping, and replace lost flood storage capacity will be significant. Furthermore, long-term monitoring and maintenance of the cap will be required since contaminants remain in place.

This alternative will not be retained for detailed analysis.

**TABLE 4-4. SCREENING OF REMEDIAL ALTERNATIVES - SEDIMENT
SD-4: SOURCE CONTROL - EXCAVATION (B&M POND) WITH DISPOSAL**

Description: Under this alternative, contaminated sediments would be excavated to remove exposure to ecological receptors. Excavated sediments would be disposed off-site. Areas outside of the excavation, including Unnamed Brook, would be monitored as part of a MNR program

Note that evaluation of effectiveness and implementability for this alternative is specific to B&M Pond. See Table 4-2 for evaluation of these parameters with respect to MNR at areas outside of the excavation.

	Effectiveness	Implementability	Cost
Advantages:	<ul style="list-style-type: none"> - Eliminates exposure to contaminated sediments 	<ul style="list-style-type: none"> - Excavation is a proven technology - Off-site treatment/disposal facilities are available to accept the material 	<ul style="list-style-type: none"> - Low O&M costs
Disadvantages:	<ul style="list-style-type: none"> - Transportation to off-site facilities increases the potential for future liability 	<ul style="list-style-type: none"> - Excavation/dredging in wetland areas may be difficult to implement 	<ul style="list-style-type: none"> - Periodic 5-year review costs - Moderate to high capital costs

Conclusion: This alternative is protective of the environment and is considered to be less difficult to implement than other alternatives.

This alternative will be retained for detailed analysis.

**TABLE 4-5. SCREENING OF REMEDIAL ALTERNATIVES - SEDIMENT
SD-5: SOURCE CONTROL - EXCAVATION WITH ON-SITE TREATMENT -
CHEMICAL EXTRACTION/SOIL WASHING**

Description: Under this alternative, contaminated sediments would be excavated to remove exposure to ecological receptors. Excavated sediments would be treated on-site. It is assumed that pre-design treatability testing will determine that chemical extraction/soil washing will be able to reduce contaminants below PRGs. Areas outside of the excavation, including Unnamed Brook, would be monitored as part of a MNR program.

Note that evaluation of effectiveness and implementability for this alternative is specific to B&M Pond. See Table 4-2 for evaluation of these parameters with respect to MNR at areas outside of the excavation.

	Effectiveness	Implementability	Cost
Advantages:	<ul style="list-style-type: none"> - Eliminates exposure to contaminated sediments - Treats the contaminants on-site 	<ul style="list-style-type: none"> - Excavation is a proven technology - Chemical extraction and soil washing are proven technologies 	<ul style="list-style-type: none"> - Low O&M costs
Disadvantages:	<ul style="list-style-type: none"> - Contaminants are transferred to other media requiring further treatment/disposal 	<ul style="list-style-type: none"> - Excavation/dredging in wetland areas may be difficult to implement - Wash water will require groundwater injection 	<ul style="list-style-type: none"> - Periodic 5-year review costs - High capital costs - Pre-processing of the sediment may make this treatment less cost-effective than other alternatives

Conclusion: This alternative is protective of the environment. The final disposition of the treated sediment is as fill for the areas excavated. However, the additional wash water treatment/disposal is expected to cause capital costs to be much higher than the other alternatives.

This alternative will not be retained for detailed analysis.

**TABLE 4-6. SCREENING OF REMEDIAL ALTERNATIVES - SEDIMENT
SD-6: SOURCE CONTROL - EXCAVATION (B&M POND AND UNNAMED BROOK)
WITH DISPOSAL**

Description: Under this alternative, contaminated sediments would be excavated from B&M Pond and Unnamed Brook to remove exposure to ecological receptors. Excavated sediments would be disposed off-site. Areas outside of the excavation would be monitored as part of a MNR program

Note that evaluation of effectiveness and implementability for this alternative is specific to B&M Pond and Unnamed Brook excavation areas. See Table 4-2 for evaluation of these parameters with respect to MNR at areas outside of the excavation.

	Effectiveness	Implementability	Cost
Advantages:	<ul style="list-style-type: none"> - Eliminates exposure to contaminated sediments 	<ul style="list-style-type: none"> - Excavation is a proven technology - Off-site treatment/disposal facilities are available to accept the material 	<ul style="list-style-type: none"> - Low O&M costs
Disadvantages:	<ul style="list-style-type: none"> - Transportation to off-site facilities increases the potential for future liability 	<ul style="list-style-type: none"> - Excavation/dredging in wetland areas and along Unnamed Brook may be difficult to implement 	<ul style="list-style-type: none"> - Periodic 5-year review costs - Moderate to high capital costs

Conclusion: This alternative is protective of the environment and, while excavation of Unnamed Brook may be difficult to implement, it is reasonable to consider this remedy relative to others.
This alternative will be retained for detailed analysis.

TABLE 5-1. NINE CRITERIA FOR DETAILED EVALUATION OF ALTERNATIVES

No	FS Evaluation Criteria	Sub-Criteria	Additional Criteria Description ⁽¹⁾
1	Overall Protection of Human Health and the Environment	<ul style="list-style-type: none"> • Human Health Protection • Environmental (e.g., Ecological) Protection 	<ul style="list-style-type: none"> · Final check to assess whether each alternative provides adequate protection of human health and the environment · Describe how site risks are eliminated, reduced, or controlled through the alternative's treatment, engineering, or institutional controls · This criterion draws on assessments conducted for criteria 2 (Compliance with ARARs), 3 (Long-Term Effectiveness and Permanence) and 5 (Short-Term Effectiveness).
2	Compliance with ARARs	<ul style="list-style-type: none"> • Compliance with Chemical-Specific ARARs • Compliance with Action-Specific ARARs • Compliance with Location-Specific ARARs 	<ul style="list-style-type: none"> · Evaluation of this criterion also needs to include compliance with other criteria, advisories, and guidance. · This assessment needs to include both federal and state ARARs.
3	Long-Term Effectiveness and Permanence	<ul style="list-style-type: none"> • Magnitude of Residual Risk • Adequacy and Reliability of Controls 	<ul style="list-style-type: none"> · The magnitude of residual risk is the assessment of risk remaining from untreated wastes or treatment residuals remaining after completion of remedial action. · The adequacy and reliability of controls is the assessment of the adequacy and suitability of controls (if any) used to manage untreated wastes or treatment residuals left on-site after completion of the remedial action.

TABLE 5-1. NINE CRITERIA FOR DETAILED EVALUATION OF ALTERNATIVES

No	FS Evaluation Criteria	Sub-Criteria	Additional Criteria Description ⁽¹⁾
4	Reduction of Toxicity, Mobility and Volume through Treatment	<ul style="list-style-type: none">• Treatment/Recycling Processes Used• Amount of Hazardous Materials Treated or Recycled• Degree of Expected Reductions in Toxicity, Mobility, or Volume• Degree to which Treatment is Irreversible• Type and Quantity of Residuals Remaining After Treatment	<ul style="list-style-type: none">• The treatment/recycling process used should address the principal threats; any special requirements should be described.• The assessment should describe the mass or volume of contaminated material destroyed/treated or recycled; the subsequent reductions in contaminant mobility should be included in the assessment.• The assessment should describe the extent to which the above treatment is irreversible.• Residuals remaining after treatment/recycling should be quantified and their characteristics described.
5	Short-Term Effectiveness	<ul style="list-style-type: none">• Protection of Community During Remedial Actions• Protection of Workers During Remedial Actions• Environmental Impacts• Time Until Remedial Action Objectives are Achieved	<ul style="list-style-type: none">• The assessment should define the risks to the community and workers during implementation of the remedial action, how the risks will be mitigated and what risks, if any, cannot be readily controlled.• The assessment should define environmental impacts during implementation of the remedial action, how impacts will be mitigated and what impacts, if any, cannot be readily controlled.• The assessment should include a quantitative estimate of the time required until remedial action objectives are achieved.

TABLE 5-1. NINE CRITERIA FOR DETAILED EVALUATION OF ALTERNATIVES

No	FS Evaluation Criteria	Sub-Criteria	Additional Criteria Description ⁽¹⁾
6	Implementability	<ul style="list-style-type: none"> • Technical Feasibility • Administrative Feasibility • Availability of Services and Materials 	<ul style="list-style-type: none"> • Technical feasibility refers to: a) ability to construct and operate the technology; b) reliability of the technology; c) ease of undertaking additional remedial actions (if required); and d) ability to monitor effectiveness of the remedy. • Administrative feasibility refers to the coordination of the remedy with other regulatory, oversight, or permitting agencies • The assessment should detail availability of the following: a) treatment, storage, and disposal services; b) any necessary equipment and specialists; and c) availability of prospective remedial technologies/process options.
7	Cost	<ul style="list-style-type: none"> • Capital Costs • Operation and Maintenance Costs 	<ul style="list-style-type: none"> • Accuracy of the cost estimates should be in the range of +50% to -30%. • The assessment should include a present worth analysis with assumption detailed on discount rate and period of performance.
8	State Acceptance	--- none ---	<ul style="list-style-type: none"> • This assessment evaluates the technical and administrative issues and concerns the state (i.e., Commonwealth of Massachusetts) may have regarding each of the alternatives. • Addressed after completion of the FS during the Proposed Plan public comment period.
9	Community Acceptance	--- none ---	<ul style="list-style-type: none"> • This assessment evaluates the issues and concerns the public (i.e., Town of Billerica) may have regarding each of the alternatives • Addressed after completion of the FS during the Proposed Plan public comment period.

Notes: (1) Reference Source: U.S. EPA, 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final*, prepared by the U.S. Environmental Protection Agency Office of Emergency and Remedial Response, Washington, D.C., OSWER Directive 9355.3-01, EPA/540/G-89/004, October, 1988.

**TABLE 5-2. DETAILED EVALUATION - GROUNDWATER
GW-1: NO ACTION**

EVALUATION CRITERIA	DETAILED ANALYSIS
OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT	
Human Health Protection	<p>This alternative would not provide any protection of human health from risks identified in the Supplemental Human Health Risk Assessment (Supplemental HHRA; M&E, 2008a).</p> <p>There would be no additional short-term human health risks associated with this alternative.</p>
Ecological Protection	<p>There were no unacceptable ecological risks associated with site groundwater.</p> <p>There would be no short-term ecological risks associated with this alternative.</p>
COMPLIANCE WITH ARARS	
Chemical-, Location-, and Action-Specific	<p>Under current conditions, chemical-specific ARARs for groundwater have not been met. Therefore, this alternative would not meet ARARs. Refer to Table C-1 in Appendix C for a list of ARARs associated with this alternative.</p>
LONG-TERM EFFECTIVENESS AND PERMANENCE	
Magnitude of Residual Risk	<p>Since this alternative includes no controls to reduce potential direct contact exposures to groundwater, the residual risk would be the same as that identified in the supplemental HHRA. Even though natural degradation processes would reduce the levels of groundwater contamination, the magnitude of that reduction would not be determined because this alternative does not include monitoring.</p>
Adequacy and Reliability of Controls	<p>This alternative does not include any controls to reduce potential future exposures to groundwater.</p>
REDUCTION OF TOXICITY, MOBILITY, AND VOLUME THROUGH TREATMENT	
Treatment Process Used and Materials Treated	<p>No treatment would be performed under this alternative.</p>
Amount Destroyed or Treated	<p>No treatment would be performed under this alternative.</p>
Degree of Expected Reductions of Toxicity, Mobility, or Volume through Treatment	<p>No treatment would be performed under this alternative.</p>
Degree to which Treatment is Irreversible	<p>No treatment would be performed under this alternative.</p>

**TABLE 5-2. DETAILED EVALUATION - GROUNDWATER
GW-1: NO ACTION**

EVALUATION CRITERIA	DETAILED ANALYSIS
Type and Quantity of Residuals Remaining after Treatment	No treatment would be performed under this alternative.
SHORT-TERM EFFECTIVENESS	
Protection of Community During Remedial Actions	Since this alternative involves no construction or monitoring measures, there would be no additional short-term risks to the community from the remedy.
Protection of Workers During Remedial Actions	Since this alternative involves no construction or monitoring measures, there would be no additional short-term risks to workers from the remedy.
Environmental Impacts	Since this alternative involves no construction or monitoring measures, there would be no adverse, short-term environmental impacts associated with the remedy.
Time to Achieve Remedial Action Objectives	Under this alternative, achieving RAOs would be dependent on natural processes in the subsurface. Without monitoring it is not possible to assess the criteria. However, based on previous modeling (M&E, 2004), the time frame would be greater than 30 years.
IMPLEMENTABILITY	
Ability to Construct and Operate	No construction or operation would be performed under this alternative.
Reliability of the Technology	No technologies would be implemented under this alternative.
Ease of Undertaking Additional Remedial Actions, If needed	If further action is deemed necessary in the future, this alternative would allow for additional remedial actions to occur.
Ability to Monitor Effectiveness	No monitoring would be conducted under this alternative. Therefore, the effectiveness would not be evaluated.
Ability to Obtain Approvals and Coordinate with Other Agencies	No approvals would likely be needed for this alternative.
Availability of Off-Site Treatment, Storage, and Disposal Services and Capacity	No off-site treatment, storage, or disposal services would be needed under this alternative.
Availability of Necessary Equipment and Specialists	No equipment or specialists would be needed under this alternative.
Availability of Technology	No technologies would be needed for this alternative.
COSTS	
Capital Cost	--
Net Present Worth of O&M Costs	--

**TABLE 5-2. DETAILED EVALUATION - GROUNDWATER
GW-1: NO ACTION**

EVALUATION CRITERIA	DETAILED ANALYSIS
Net Present Worth of Periodic Costs	\$24,800
Total Net Present Worth Cost	\$24,800

**TABLE 5-3. DETAILED EVALUATION - GROUNDWATER
GW-2: LIMITED ACTION**

EVALUATION CRITERIA	DETAILED ANALYSIS
OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT	
Human Health Protection	<p>This alternative would eliminate potential human direct contact exposures to groundwater as a potable water supply, so long as ICs are enforced such that contaminated groundwater from the site does not migrate beyond the compliance boundary. A compliance boundary will be established whereby monitoring will confirm that COCs migrating beyond the compliance boundary are below site PRGs. Natural attenuation processes may not achieve unrestricted groundwater use standards over time within the compliance boundary.</p> <p>Short-term human health risks associated with monitoring well installation and environmental monitoring would be mitigated through the use of proper personal protection equipment (PPE).</p>
Ecological Protection	<p>There were no unacceptable ecological risks associated with site groundwater.</p> <p>Short-term, minor impacts to ecological habitat due to monitoring well installation and environmental monitoring would occur.</p>
COMPLIANCE WITH ARARS	
Chemical-, Location-, and Action-Specific	<p>Under this alternative, monitoring will be performed until groundwater achieves chemical-specific ARARs within the compliance boundary. Although this is not expected to occur in a reasonable amount of time, these ARARs will be achieved beyond the compliance boundary upon its establishment. Refer to Table C-2 in Appendix C for a list of ARARs associated with this alternative.</p>
LONG-TERM EFFECTIVENESS AND PERMANENCE	
Magnitude of Residual Risk	<p>The type and quantity of contaminants remaining at the site following implementation of this limited action remedy is similar to current conditions, except for whatever attenuates naturally. ICs would be implemented as protection against accessing the groundwater as a potable water supply and would be maintained until all groundwater cleanup standards are achieved.</p>
Adequacy and Reliability of Controls	<p>Adequacy of the limited action alternative will be determined through long-term monitoring. ICs are reliable if properly enforced.</p>
REDUCTION OF TOXICITY, MOBILITY, AND VOLUME THROUGH TREATMENT	
Treatment Process Used and Materials Treated	<p>No treatment would be performed under this alternative.</p>
Amount Destroyed or Treated	<p>No treatment would be performed under this alternative.</p>

**TABLE 5-3. DETAILED EVALUATION - GROUNDWATER
GW-2: LIMITED ACTION**

EVALUATION CRITERIA	DETAILED ANALYSIS
Degree of Expected Reductions of Toxicity, Mobility, or Volume through Treatment	No treatment would be performed under this alternative.
Degree to which Treatment is Irreversible	No treatment would be performed under this alternative.
Type and Quantity of Residuals Remaining after Treatment	No treatment would be performed under this alternative.
SHORT-TERM EFFECTIVENESS	
Protection of Community During Remedial Actions	Short-term community risks associated with environmental monitoring would be minor.
Protection of Workers During Remedial Actions	Short-term worker risks associated with well installation and environmental monitoring would be mitigated through the use of proper PPE.
Environmental Impacts	Short-term, minor impacts to ecological habitat due to monitoring well installation and environmental monitoring would occur.
Time to Achieve Remedial Action Objectives	RAOs associated with preventing direct contact exposures to groundwater by future residential receptors would be assumed to be achieved upon implementation of ICs (likely less than five years). The time frame for site close-out, based on achieving PRGs, is expected to be greater than 30 years, based on previous modeling (M&E, 2004).
IMPLEMENTABILITY	
Ability to Construct and Operate	Monitoring is common and easy to implement.
Reliability of the Technology	Monitoring can be reliable to determine migration and attenuation trends, but will not actively reduce contaminant concentrations. ICs are reliable in achieving RAOs as long as they are enforced.
Ease of Undertaking Additional Remedial Actions, If needed	If further action is deemed necessary in the future, this alternative would allow for additional remedial actions to occur.
Ability to Monitor Effectiveness	Multiple monitoring locations would be sampled to evaluate the effectiveness of the remedy.
Ability to Obtain Approvals and Coordinate with Other Agencies	ICs would require coordination with other agencies.
Availability of Off-Site Treatment, Storage, and Disposal Services and Capacity	No off-site treatment, storage, or disposal services would be needed under this alternative.

**TABLE 5-3. DETAILED EVALUATION - GROUNDWATER
GW-2: LIMITED ACTION**

EVALUATION CRITERIA	DETAILED ANALYSIS
Availability of Necessary Equipment and Specialists	There are many contractors available to provide the equipment and services required by this alternative.
Availability of Technology	Groundwater monitoring does not require special technologies.
COSTS	
Capital Cost	\$224,577
Net Present Worth of O&M Costs	\$1,012,852
Net Present Worth of Periodic Costs	\$42,863
Total Net Present Worth Cost	\$1,280,292

**TABLE 5-4. DETAILED EVALUATION - SEDIMENT
SD-1: NO ACTION**

EVALUATION CRITERIA	DETAILED ANALYSIS
OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT	
Human Health Protection	<p>There were no unacceptable human health risks associated with site sediment.</p> <p>There would be no short-term human health risks associated with this alternative.</p>
Ecological Protection	<p>This alternative would not provide protection of ecological receptors from potential risks due to exposure to sediments in the B&M Pond and the Unnamed Brook identified in the Ecological Risk Assessment/Wetlands Remedial Investigation Addendum (ERA/WRIA; M&E, 2006a).</p> <p>There would be no additional short-term ecological risks associated with this alternative.</p>
COMPLIANCE WITH ARARS	
Chemical-, Location-, and Action-Specific	Under current conditions, chemical-specific To Be Considered criteria for sediment have not been met. Therefore, this alternative would not be considered as meeting ARARs. Refer to Table C-3 in Appendix C for a list of ARARs associated with this alternative.
LONG-TERM EFFECTIVENESS AND PERMANENCE	
Magnitude of Residual Risk	Since this alternative includes no controls to reduce potential exposures to contaminated sediments, any potential residual risk would not be changed.
Adequacy and Reliability of Controls	This alternative does not include any controls to reduce potential future exposures to contaminated sediments.
REDUCTION OF TOXICITY, MOBILITY, AND VOLUME THROUGH TREATMENT	
Treatment Process Used and Materials Treated	No treatment would be performed under this alternative.
Amount Destroyed or Treated	No treatment would be performed under this alternative.
Degree of Expected Reductions of Toxicity, Mobility, or Volume through Treatment	No treatment would be performed under this alternative.
Degree to which Treatment is Irreversible	No treatment would be performed under this alternative.

**TABLE 5-4. DETAILED EVALUATION - SEDIMENT
SD-1: NO ACTION**

EVALUATION CRITERIA	DETAILED ANALYSIS
Type and Quantity of Residuals Remaining after Treatment	No treatment would be performed under this alternative.
SHORT-TERM EFFECTIVENESS	
Protection of Community During Remedial Actions	Since this alternative involves no construction or monitoring measures, there would be no additional short-term risks to the community from the remedy.
Protection of Workers During Remedial Actions	Since this alternative involves no construction or monitoring measures, there would be no additional short-term risks to workers from the remedy.
Environmental Impacts	Since this alternative involves no construction or monitoring measures, there would be no adverse, short-term environmental impacts associated with the remedy.
Time to Achieve Remedial Action Objectives	This alternative would not achieve RAOs.
IMPLEMENTABILITY	
Ability to Construct and Operate	No construction or operation would be performed under this alternative.
Reliability of the Technology	No technologies would be implemented under this alternative.
Ease of Undertaking Additional Remedial Actions, If needed	If further action is deemed necessary in the future, this alternative would allow for additional remedial actions to occur.
Ability to Monitor Effectiveness	No monitoring would be conducted under this alternative. Therefore, the effectiveness would not be evaluated.
Ability to Obtain Approvals and Coordinate with Other Agencies	No approvals would likely be needed for this alternative.
Availability of Off-Site Treatment, Storage, and Disposal Services and Capacity	No off-site treatment, storage, or disposal services would be needed under this alternative.
Availability of Necessary Equipment and Specialists	No equipment or specialists would be needed under this alternative.
Availability of Technology	No technologies would be needed for this alternative.
COSTS	
Capital Cost	--

**TABLE 5-4. DETAILED EVALUATION - SEDIMENT
SD-1: NO ACTION**

EVALUATION CRITERIA	DETAILED ANALYSIS
Net Present Worth of O&M Costs	--
Net Present Worth of Periodic Costs	\$24,800
Total Net Present Worth Cost	\$24,800

**TABLE 5-5. DETAILED EVALUATION - SEDIMENT
SD-4: SOURCE CONTROL – EXCAVATION (B&M POND) WITH DISPOSAL**

EVALUATION CRITERIA	DETAILED ANALYSIS
OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT	
Human Health Protection	<p>There were no unacceptable human health risks associated with site sediment.</p> <p>Short-term human health risks associated with excavation, disposal, and environmental monitoring would be mitigated through the use of proper personal protection equipment (PPE).</p>
Ecological Protection	<p>Through removal of contaminated sediments in B&M Pond and via MNR in areas outside the excavation (including Unnamed Brook), this alternative would provide protection of ecological receptors from potential risks due to exposure to sediments identified in the Ecological Risk Assessment/Wetlands Remedial Investigation Addendum (ERA/WRIA; M&E, 2006a). Based on available monitoring data, it is assumed that the MNR time frame to achieve PRGs would be less than 20 years (see Appendix B).</p> <p>Short-term impacts to ecological habitat would occur as a result of the sediment excavation. Wetland mitigation, including replacement of the excavated sediment, will be performed. Short-term, minor impacts to ecological habitat due to environmental monitoring would also occur.</p>
COMPLIANCE WITH ARARS	
Chemical-, Location-, and Action-Specific	All chemical-, location-, and action-specific ARARs would be complied with. Refer to Table C-4 in Appendix C for a list of ARARs associated with this alternative.
LONG-TERM EFFECTIVENESS AND PERMANENCE	
Magnitude of Residual Risk	The excavation would be expected to significantly reduce ecological risks for B&M Pond sediment. Outside of this excavation, the residual risk is expected to be reduced to acceptable levels over time as the PRGs are approached/achieved.
Adequacy and Reliability of Controls	Excavation is a reliable means for removing contaminated sediment. Based on site monitoring results, MNR is an adequate and reliable method for achieving RAOs.
REDUCTION OF TOXICITY, MOBILITY, AND VOLUME THROUGH TREATMENT	
Treatment Process Used and Materials Treated	While sediment excavation will be conducted, no treatment would be performed under this alternative.
Amount Destroyed or Treated	No treatment would be performed under this alternative.

**TABLE 5-5. DETAILED EVALUATION - SEDIMENT
SD-4: SOURCE CONTROL – EXCAVATION (B&M POND) WITH DISPOSAL**

EVALUATION CRITERIA	DETAILED ANALYSIS
Degree of Expected Reductions of Toxicity, Mobility, or Volume through Treatment	No treatment would be performed under this alternative.
Degree to which Treatment is Irreversible	No treatment would be performed under this alternative.
Type and Quantity of Residuals Remaining after Treatment	No treatment would be performed under this alternative.
SHORT-TERM EFFECTIVENESS	
Protection of Community During Remedial Actions	Short-term community risks associated with remedy implementation and environmental monitoring would be minor. Off-site sediment disposal will result in increased local truck traffic. However, these impacts would be mitigated as necessary.
Protection of Workers During Remedial Actions	Short-term worker risks associated with remedy implementation and environmental monitoring would be mitigated through the use of proper PPE.
Environmental Impacts	Short-term impacts to ecological habitat would occur as a result of the excavation, but wetland mitigation would be performed.
Time to Achieve Remedial Action Objectives	Achieving RAOs associated with sediment exposure to ecological receptors would be limited by MNR occurring in areas outside of the B&M Pond excavation. Based on available monitoring data, it is assumed that RAOs would be achieved in less than 20 years (see Appendix B).
IMPLEMENTABILITY	
Ability to Construct and Operate	<p>Sediment excavation or dredging within wetland areas is common, but can often be difficult to implement. Access will likely occur via a roadway over the planned cap for B&M Railroad Landfill (AOC 1 under OU-3), so care will be necessary so as to not damage the cap.</p> <p>MNR is now considered a common remedy for sediment. However, monitoring for parameters such as sediment types, erosion, deposition, and other fate and transport properties can be difficult in a wetland environment.</p>
Reliability of the Technology	<p>Excavation is known to be reliable.</p> <p>Based on available site data, MNR is expected to be reliable. While high flow conditions can both remove contaminants as well as cover sediments, the site streams/water bodies do not appear to achieve flow rates which would reduce the reliability of the remedy.</p>
Ease of Undertaking Additional Remedial Actions, If needed	If further action is deemed necessary in the future, this alternative would allow for additional remedial actions to occur on remaining sediments.

**TABLE 5-5. DETAILED EVALUATION - SEDIMENT
SD-4: SOURCE CONTROL – EXCAVATION (B&M POND) WITH DISPOSAL**

EVALUATION CRITERIA	DETAILED ANALYSIS
Ability to Monitor Effectiveness	Monitoring (both confirmatory around the excavation and in other areas outside the excavation) would be conducted to evaluate the effectiveness of the remedy.
Ability to Obtain Approvals and Coordinate with Other Agencies	Approvals for disposal of contaminated sediment and water from dewatering would require coordination with other agencies. Sediment monitoring may require coordination with other agencies (e.g., conservation commission and/or property owners).
Availability of Off-Site Treatment, Storage, and Disposal Services and Capacity	Multiple facilities would be able to accept the excavated materials for final disposition.
Availability of Necessary Equipment and Specialists	There are many contractors available to provide the equipment and services required by this alternative.
Availability of Technology	This alternative contains commonly-used technologies.
COSTS	
Capital Cost	\$3,423,744
Net Present Worth of O&M Costs	\$627,458
Net Present Worth of Periodic Costs	\$21,180
Total Net Present Worth Cost	\$4,072,381

**TABLE 5-6. DETAILED EVALUATION - SEDIMENT
SD-6: SOURCE CONTROL – EXCAVATION (B&M POND AND UNNAMED BROOK)
WITH DISPOSAL**

EVALUATION CRITERIA	DETAILED ANALYSIS
OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT	
Human Health Protection	<p>There were no unacceptable human health risks associated with site sediment.</p> <p>Short-term human health risks associated with excavation and disposal would be mitigated through the use of proper personal protection equipment (PPE).</p>
Ecological Protection	<p>Through removal of contaminated sediments in B&M Pond and Unnamed Brook, this alternative would provide protection of ecological receptors from potential risks due to exposure to sediments identified in the Ecological Risk Assessment/Wetlands Remedial Investigation Addendum (ERA/WRIA; M&E, 2006a).</p> <p>Short-term impacts to ecological habitat would occur as a result of the sediment excavation. Wetland mitigation, including replacement of the excavated sediment, will be performed.</p>
COMPLIANCE WITH ARARS	
Chemical-, Location-, and Action-Specific	All chemical-, location-, and action-specific ARARs would be complied with. Refer to Table C-5 in Appendix C for a list of ARARs associated with this alternative.
LONG-TERM EFFECTIVENESS AND PERMANENCE	
Magnitude of Residual Risk	The excavation would be expected to significantly reduce ecological risks for site sediment, where residual risk is expected to be reduced to acceptable levels as the PRGs are achieved.
Adequacy and Reliability of Controls	Excavation is a reliable means for removing contaminated sediment.
REDUCTION OF TOXICITY, MOBILITY, AND VOLUME THROUGH TREATMENT	
Treatment Process Used and Materials Treated	While sediment excavation will be conducted, no treatment would be performed under this alternative.
Amount Destroyed or Treated	No treatment would be performed under this alternative.
Degree of Expected Reductions of Toxicity, Mobility, or Volume through Treatment	No treatment would be performed under this alternative.
Degree to which Treatment is Irreversible	No treatment would be performed under this alternative.
Type and Quantity of Residuals Remaining after Treatment	No treatment would be performed under this alternative.

TABLE 5-6. DETAILED EVALUATION - SEDIMENT
SD-6: SOURCE CONTROL – EXCAVATION (B&M POND AND UNNAMED BROOK)
WITH DISPOSAL

EVALUATION CRITERIA	DETAILED ANALYSIS
SHORT-TERM EFFECTIVENESS	
Protection of Community During Remedial Actions	Short-term community risks associated with remedy implementation would be minor. Off-site sediment disposal will result in increased local truck traffic. However, these impacts would be mitigated as necessary.
Protection of Workers During Remedial Actions	Short-term worker risks associated with remedy implementation would be mitigated through the use of proper PPE.
Environmental Impacts	Short-term impacts to ecological habitat would occur as a result of the excavation, but wetland mitigation would be performed.
Time to Achieve Remedial Action Objectives	RAOs for sediment would be achieved upon removal of contaminated sediment. This is assumed to be less than five years.
IMPLEMENTABILITY	
Ability to Construct and Operate	<p>Sediment excavation or dredging within wetland areas is common, but can often be difficult to implement. Access to B&M Pond will likely occur via a roadway over the planned cap for B&M Railroad Landfill (AOC 1 under OU-3), so care will be necessary so as to not damage the cap.</p> <p>Access to Unnamed Brook may be difficult in some areas and diverting the brook may also be necessary.</p>
Reliability of the Technology	Excavation is known to be reliable.
Ease of Undertaking Additional Remedial Actions, If needed	If further action is deemed necessary in the future, this alternative would allow for additional remedial actions to occur on remaining sediments.
Ability to Monitor Effectiveness	Confirmatory sampling would be conducted to evaluate the effectiveness of the remedy.
Ability to Obtain Approvals and Coordinate with Other Agencies	Approvals for disposal of contaminated sediment and water from dewatering would require coordination with other agencies.
Availability of Off-Site Treatment, Storage, and Disposal Services and Capacity	Multiple facilities would be able to accept the excavated materials for final disposition.
Availability of Necessary Equipment and Specialists	There are many contractors available to provide the equipment and services required by this alternative.
Availability of Technology	This alternative contains commonly-used technologies.
COSTS	
Capital Cost	\$5,412,289

**TABLE 5-6. DETAILED EVALUATION - SEDIMENT
SD-6: SOURCE CONTROL – EXCAVATION (B&M POND AND UNNAMED BROOK)
WITH DISPOSAL**

EVALUATION CRITERIA	DETAILED ANALYSIS
Net Present Worth of O&M Costs	\$0
Net Present Worth of Periodic Costs	\$0
Total Net Present Worth Cost	\$5,412,289

TABLE 6-1. ABBREVIATED COMPARATIVE ANALYSIS OF THE REMEDIAL TECHNOLOGIES
GROUNDWATER

	No Action	Limited Action
Overall Protection of Human Health and the Environment	<input type="checkbox"/> - No Protection, <input checked="" type="checkbox"/> - Partially Protective, <input checked="" type="checkbox"/> - Protective	
Protection of Human Health	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Ecological Protection Does not exceed risk limits	N/A	N/A
Compliance with ARARs	<input type="checkbox"/> - Does Not Meet, <input checked="" type="checkbox"/> - May Not Meet/Partially Meets, <input checked="" type="checkbox"/> - Meets	
	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Long-Term Effectiveness And Permanence	<input type="checkbox"/> - No Protection, <input checked="" type="checkbox"/> - Partially Protective, <input checked="" type="checkbox"/> - Protective	
Magnitude of Residual Risk - Human Health:	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Magnitude of Residual Risk - Ecological Does not exceed risk limits	N/A	N/A
Reduction of Toxicity, Mobility and Volume through Treatment		
Treatment/Recycling Processes Utilized	None	None
Amount of Hazardous Materials Treated or Recycled	<input type="checkbox"/> - Low, <input checked="" type="checkbox"/> - Moderate, <input checked="" type="checkbox"/> - High N/A	 N/A
Degree of Expected Reductions in Toxicity, Mobility or Volume	<input type="checkbox"/> - Low, <input checked="" type="checkbox"/> - Moderate, <input checked="" type="checkbox"/> - High N/A	 N/A
Irreversibility	<input type="checkbox"/> - Reversible, <input checked="" type="checkbox"/> - Moderately Reversible, <input checked="" type="checkbox"/> - Irreversible N/A	 N/A
Type and Quantity of [Process] Residuals	<input type="checkbox"/> - High, <input checked="" type="checkbox"/> - Moderate, <input checked="" type="checkbox"/> - Low N/A	 N/A
Short-Term Effectiveness	<input type="checkbox"/> - High Impacts, <input checked="" type="checkbox"/> - Moderate Impacts, <input checked="" type="checkbox"/> - Low Impacts	
Protection of Community and Workers During Remedial Actions	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Environmental Impacts	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Time Until Remedial Action Objectives are Achieved	>30 years	< 5 years
Implementability	<input type="checkbox"/> - High Effort/Low Reliability, <input checked="" type="checkbox"/> - Moderate Effort/Moderate Reliability, <input checked="" type="checkbox"/> - Low Effort/High Reliability	
Technical Feasibility: Construction, operation & maintenance Reliability in achieving RAOs Implementation of future actions	<input checked="" type="checkbox"/> N/A <input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/>
Administrative Feasibility	<input type="checkbox"/> - High Effort, <input checked="" type="checkbox"/> - Moderate to High Effort, <input checked="" type="checkbox"/> - Low to Moderate Effort <input checked="" type="checkbox"/>	 <input checked="" type="checkbox"/>
Availability of Services and Materials	<input type="checkbox"/> - High Effort/Not Commonly Available, <input checked="" type="checkbox"/> - Moderate Effort & Availability, <input checked="" type="checkbox"/> - Low Effort/Commonly Available <input checked="" type="checkbox"/>	 <input checked="" type="checkbox"/>
Cost (Present Value)		
Capital (\$thousand)	\$0.0	\$224
O&M (\$thousand)	\$0.0	\$1,013
Periodic (\$thousand)	<u>\$24.8</u>	<u>\$43</u>
Total (\$thousand)	<u>\$24.8</u>	<u>\$1,280</u>

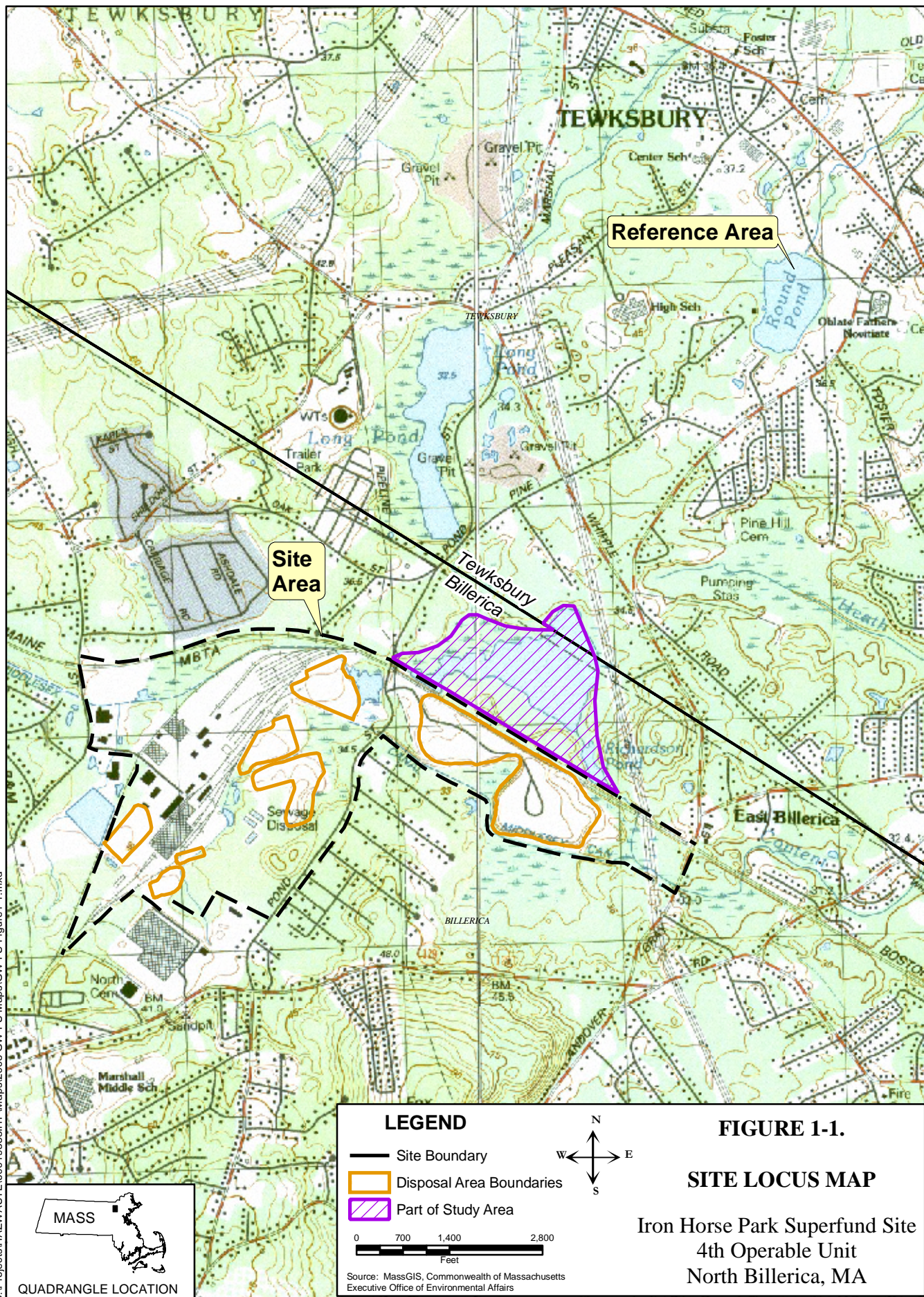
N/A - Not Applicable

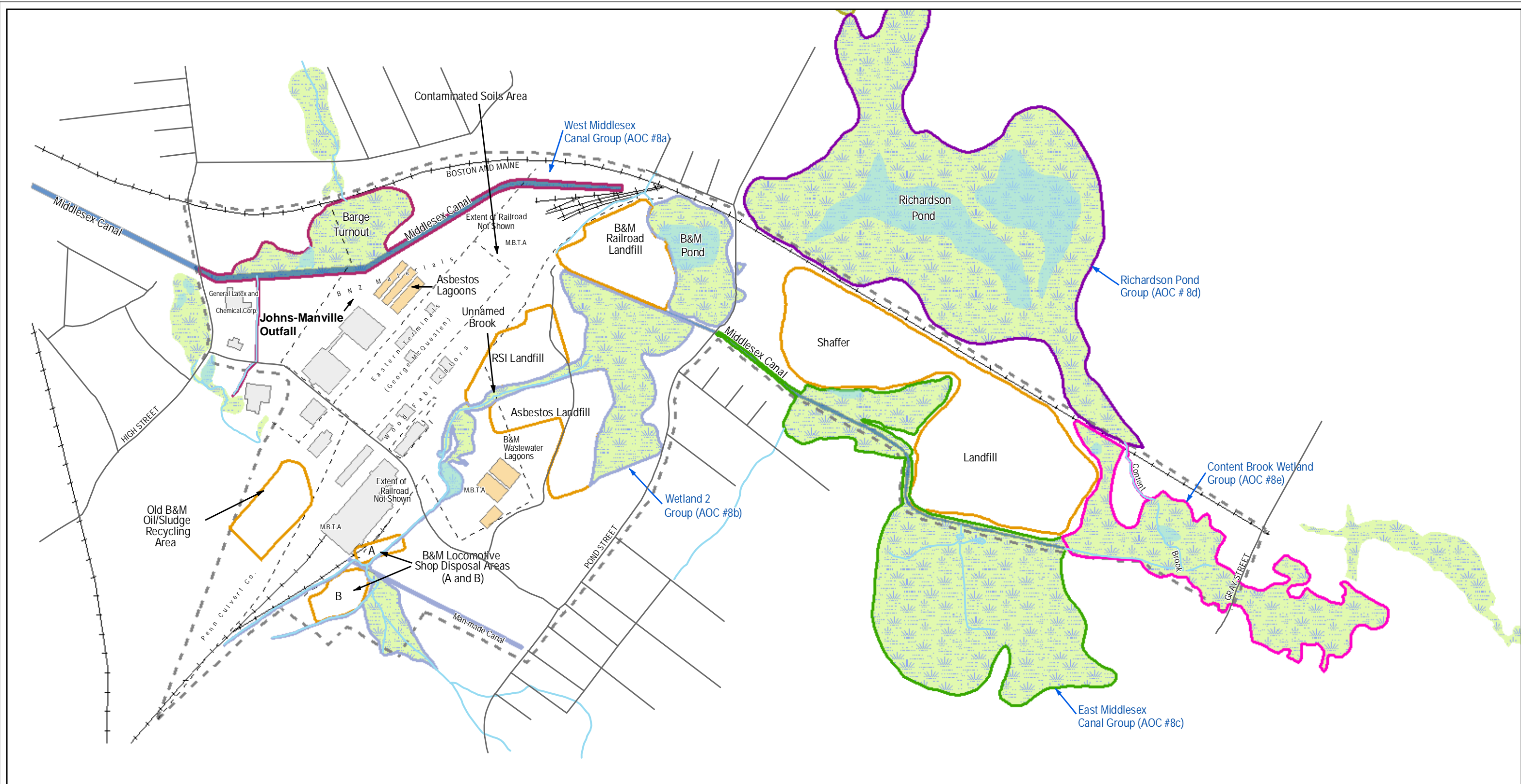
TABLE 6-2. ABBREVIATED COMPARATIVE ANALYSIS OF THE REMEDIAL TECHNOLOGIES
SEDIMENT

	No Action	Source Control - Excavation (B&M Pond) with Disposal	Source Control - Excavation (B&M Pond and Unnamed Brook) with Disposal
<u>Overall Protection of Human Health and the Environment</u>	☐ - No Protection, ▣ - Partially Protective, ■ - Protective		
Protection of Human Health Does not exceed risk limits	N/A	N/A	N/A
Ecological Protection	☐	■	■
<u>Compliance with ARARs</u>	☐ - Does Not Meet, ▣ - May Not Meet/Partially Meets, ■ - Meets		
	☐	■	■
<u>Long-Term Effectiveness And Permanence</u>	☐ - No Protection, ▣ - Partially Protective, ■ - Protective		
Magnitude of Residual Risk - Human Health: Does not exceed risk limits	N/A	N/A	N/A
Magnitude of Residual Risk - Ecological	☐	■	■
<u>Reduction of Toxicity, Mobility and Volume through Treatment</u>			
Treatment/Recycling Processes Utilized	None	None	None
Amount of Hazardous Materials Treated or Recycled	☐ - Low, ▣ - Moderate, ■ - High N/A	N/A	N/A
Degree of Expected Reductions in Toxicity, Mobility or Volume	☐ - Low, ▣ - Moderate, ■ - High N/A	N/A	N/A
Irreversibility	☐ - Reversible, ▣ - Moderately Reversible, ■ - Irreversible		
	N/A	N/A	N/A
Type and Quantity of [Process] Residuals	☐ - High, ▣ - Moderate, ■ - Low N/A	N/A	N/A
<u>Short-Term Effectiveness</u>	☐ - High Impacts, ▣ - Moderate Impacts, ■ - Low Impacts		
Protection of Community and Workers During Remedial Actions	■	▣	▣
Environmental Impacts	■	▣	▣
Time Until Remedial Action Objectives are Achieved	Would not meet RAOs	< 20 years	< 5 years
<u>Implementability</u>	☐ - High Effort/Low Reliability, ▣ - Moderate Effort/Moderate Reliability, ■ - Low Effort/High Reliability		
Technical Feasibility: Construction, operation & maintenance	■	▣	▣
Reliability in achieving RAOs	N/A	■	■
Implementation of future actions	■	■	■
Administrative Feasibility	☐ - High Effort, ▣ - Moderate to High Effort, ■ - Low to Moderate Effort		
	■	▣	▣
Availability of Services and Materials	☐ - High Effort/Not Commonly Available, ▣ - Moderate Effort & Availability, ■ - Low Effort/Commonly Available		
	■	■	■
<u>Cost (Present Value)</u>			
Capital (\$thousand)	\$0.0	\$3,424	\$5,412
O&M (\$thousand)	\$0.0	\$627	\$0
Periodic (\$thousand)	\$24.8	\$21	\$0
Total (\$thousand)	\$24.8	\$4,072	\$5,412

N/A - Not Applicable

FIGURES





LEGEND

- Property Boundary
- Site Boundary
- Roads
- Railroad
- Disposal Area Boundary
- Approximate Location of Johns-Manville Outfall

- Surface Water
- Wetlands
- Lagoon
- Building

- Content Brook Wetland Group
- East Middlesex Canal Group
- Richardson Pond Group
- West Middlesex Canal Group
- Wetland 2 Group

Locations for all features area approximate.
 Extent of wetland and surface waters are limited to areas confirmed during wetlands reconnaissance on July 15, 1993 and November 8, 1994.

Source: MassGIS, Commonwealth of Massachusetts
 Executive Office of Environmental Affairs

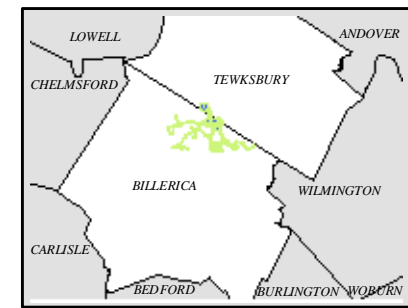


FIGURE 1-2

SITE MAP

Iron Horse Park Superfund Site
 4th Operable Unit
 North Billerica, MA

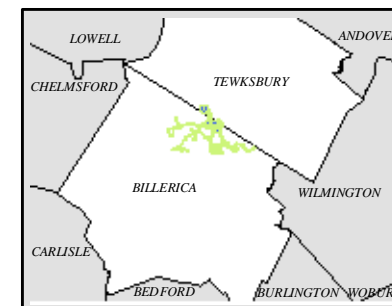
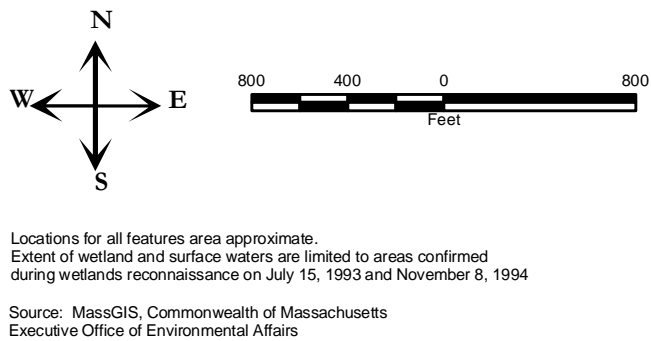
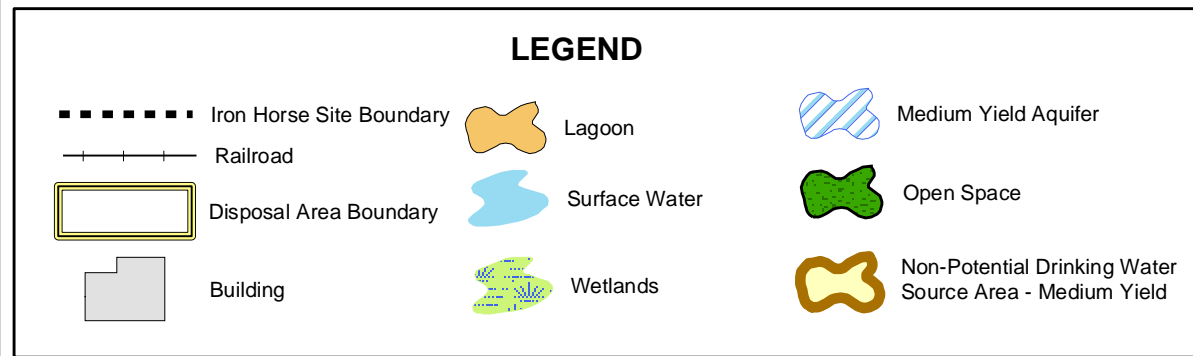
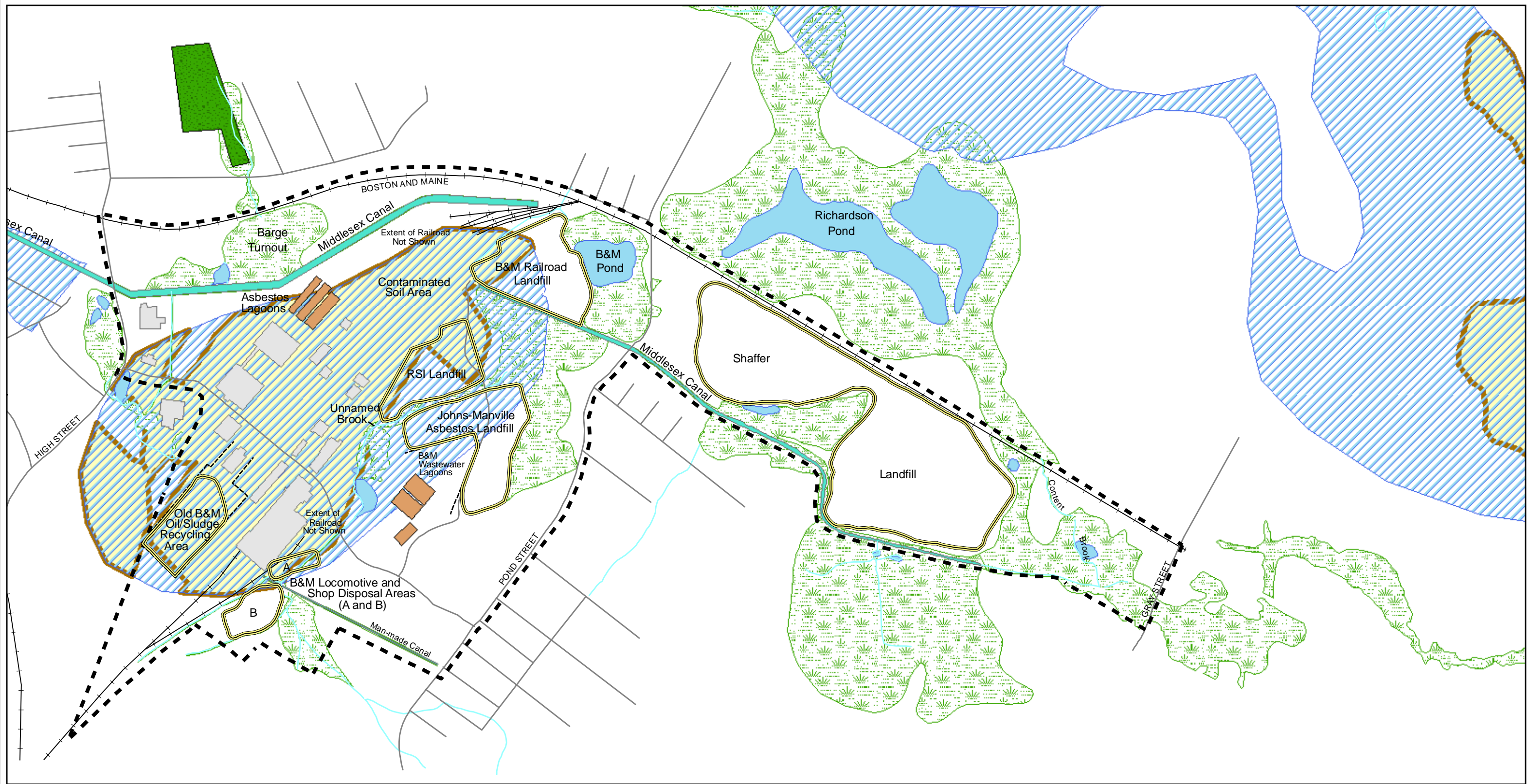
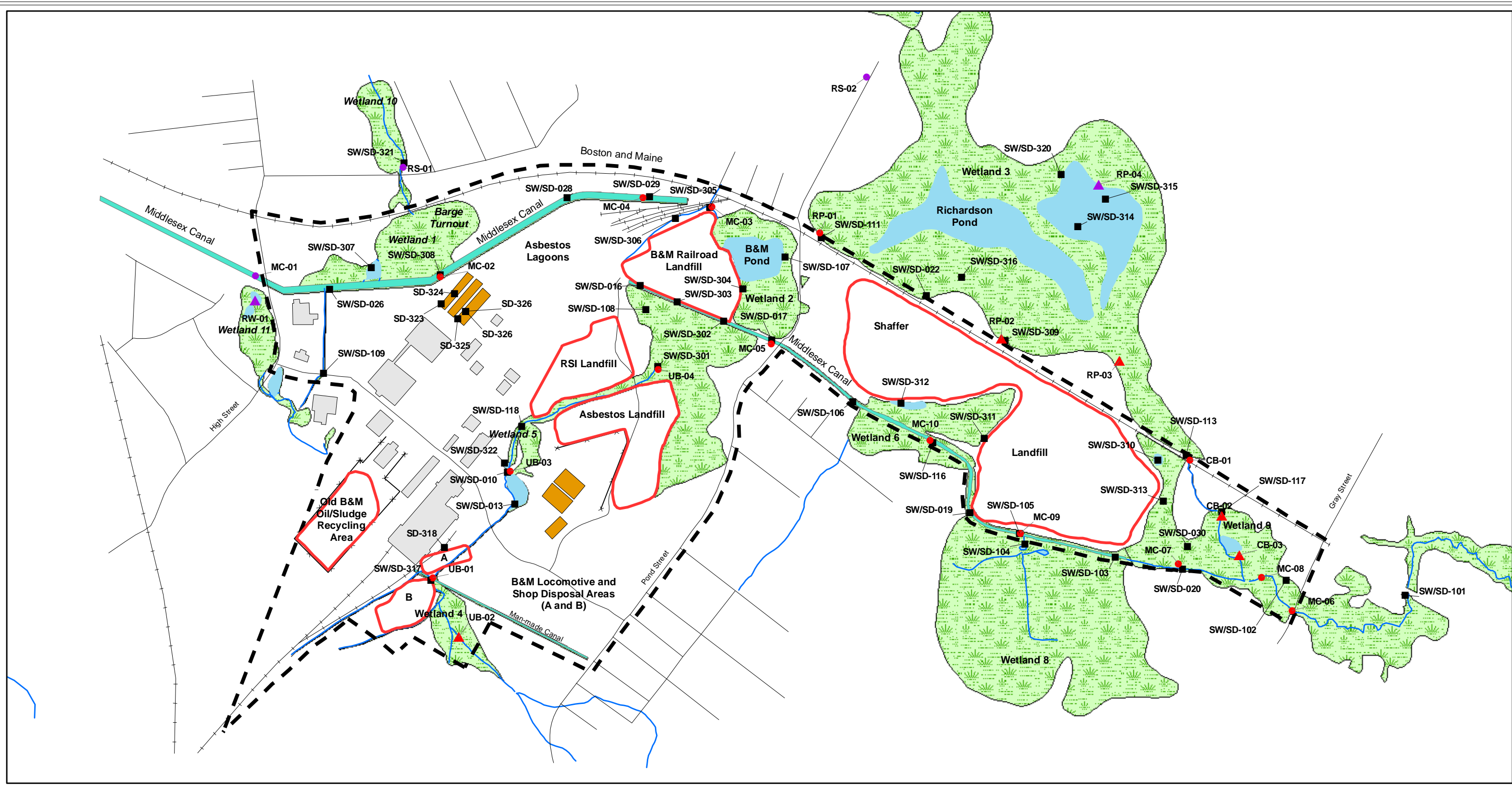


FIGURE 1-3.
AQUIFERS AND OPEN SPACES

Iron Horse Park Superfund Site
 4th Operable Unit
 North Billerica, MA



LEGEND

— Road	Surface Water	Building	■ Surface Water/Sediment Station
—+— Railroad	Wetland	Canal	▲ Lentic Station
— Stream	Lagoon		▲ Lentic Reference Station
×—× Fence			● Lotic Station
— Disposal Area boundary			● Lotic Reference Station
--- Iron Horse Site Boundary			

N
 W ← → E
 S

0 200 400 800 1,200 1,600
Feet

Locations for all features area approximate.
Extent of wetland and surface waters are limited to areas confirmed during wetlands reconnaissance on July 15, 1993 and November 8, 1994

Source: MassGIS, Commonwealth of Massachusetts
Executive Office of Environmental Affairs

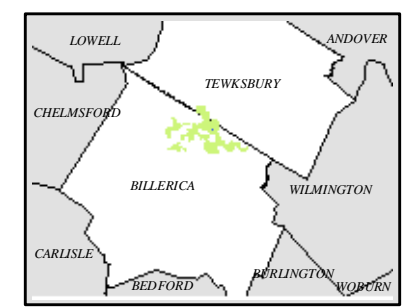


FIGURE 1-4.

1997 BERA BENTHIC INVERTEBRATE AND SEDIMENT SAMPLING LOCATIONS

Iron Horse Park Superfund Site
4th Operable Unit
North Billerica, MA

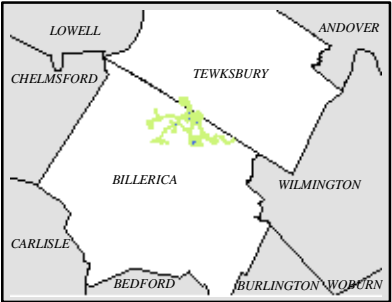
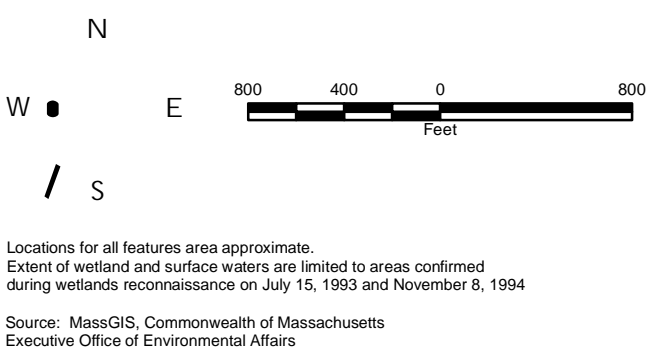
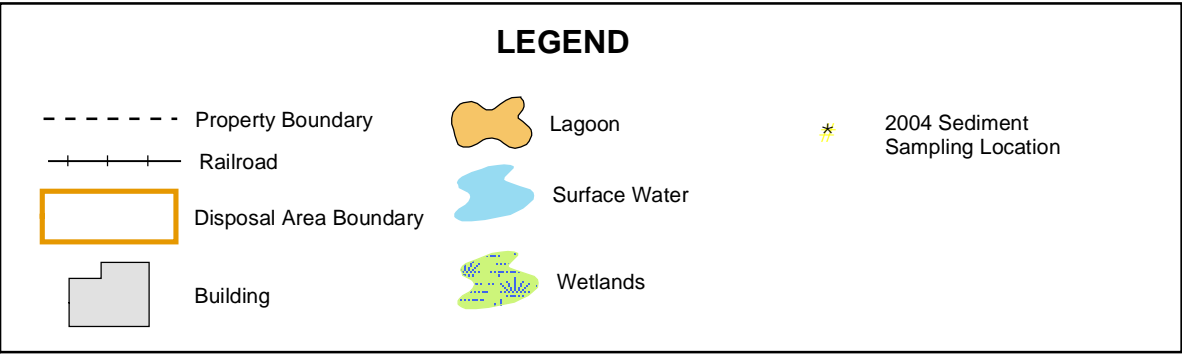
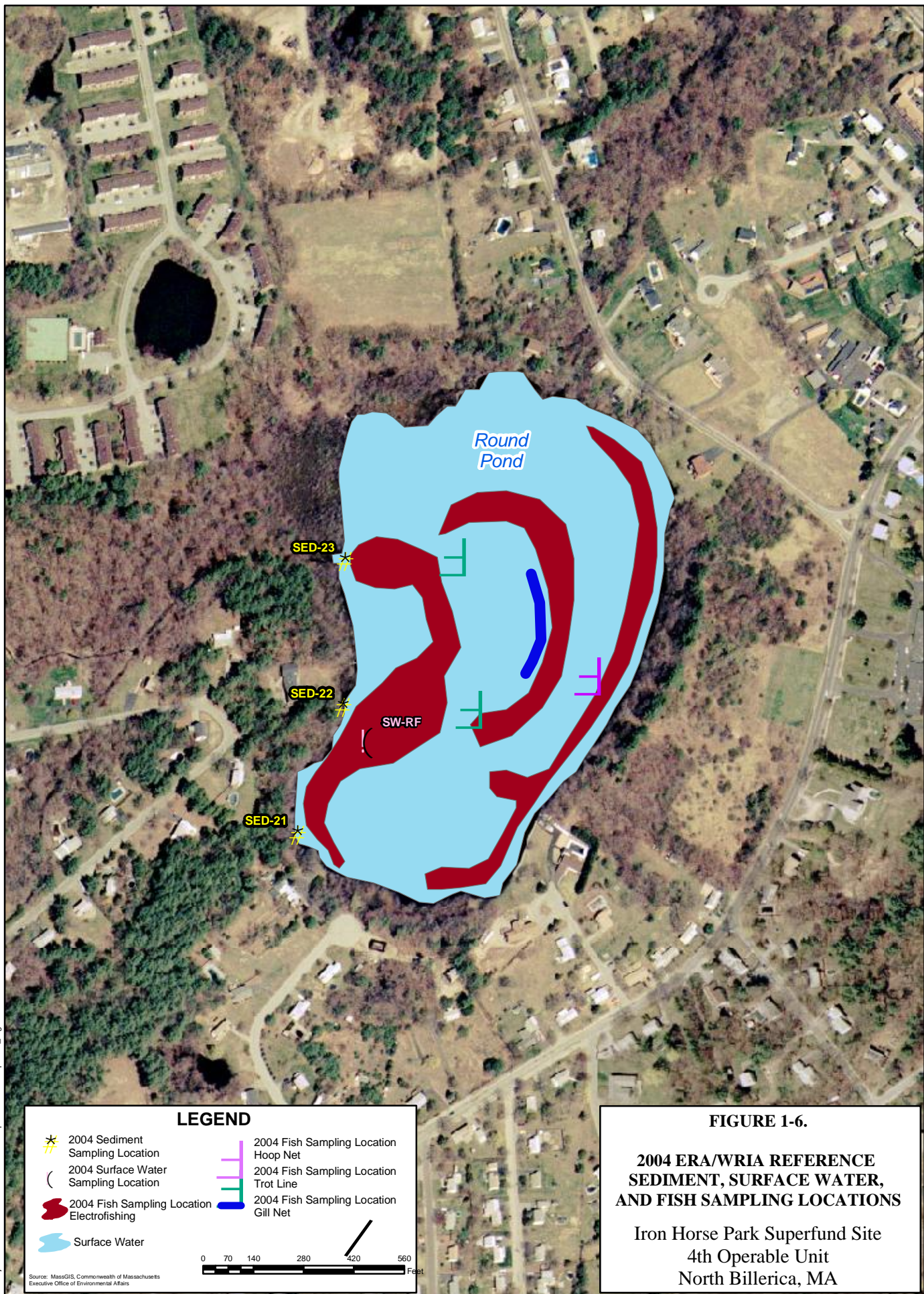


FIGURE 1-5.

2004 ERA/WRIA SEDIMENT SAMPLING LOCATIONS FOR SCREENING-LEVEL ANALYSIS

Iron Horse Park Superfund Site
4th Operable Unit
North Billerica, MA



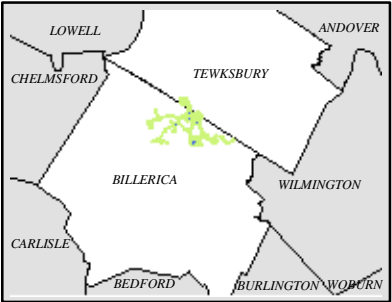
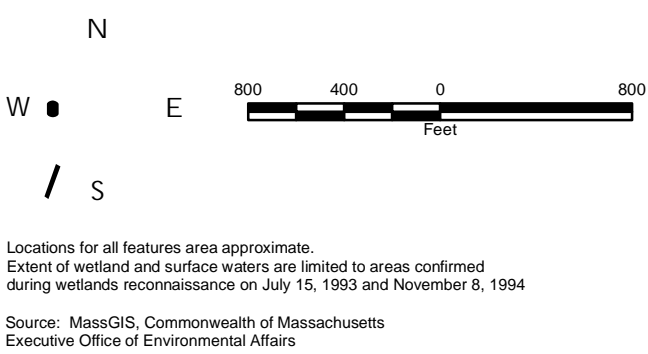
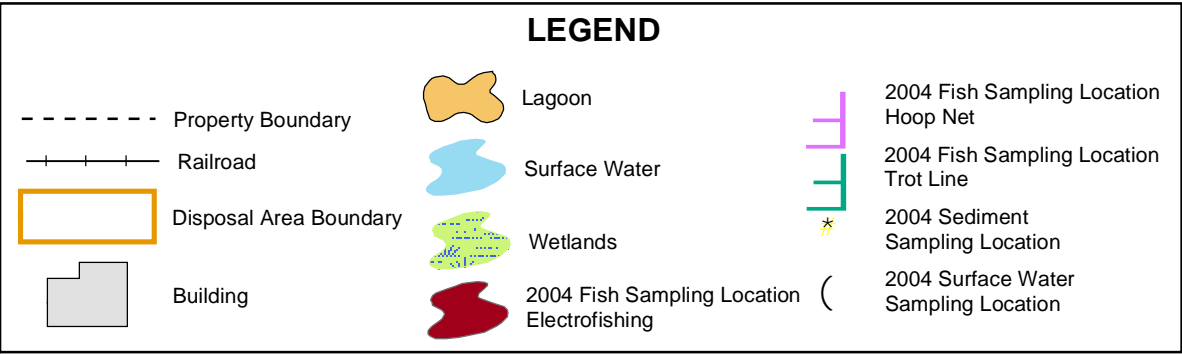
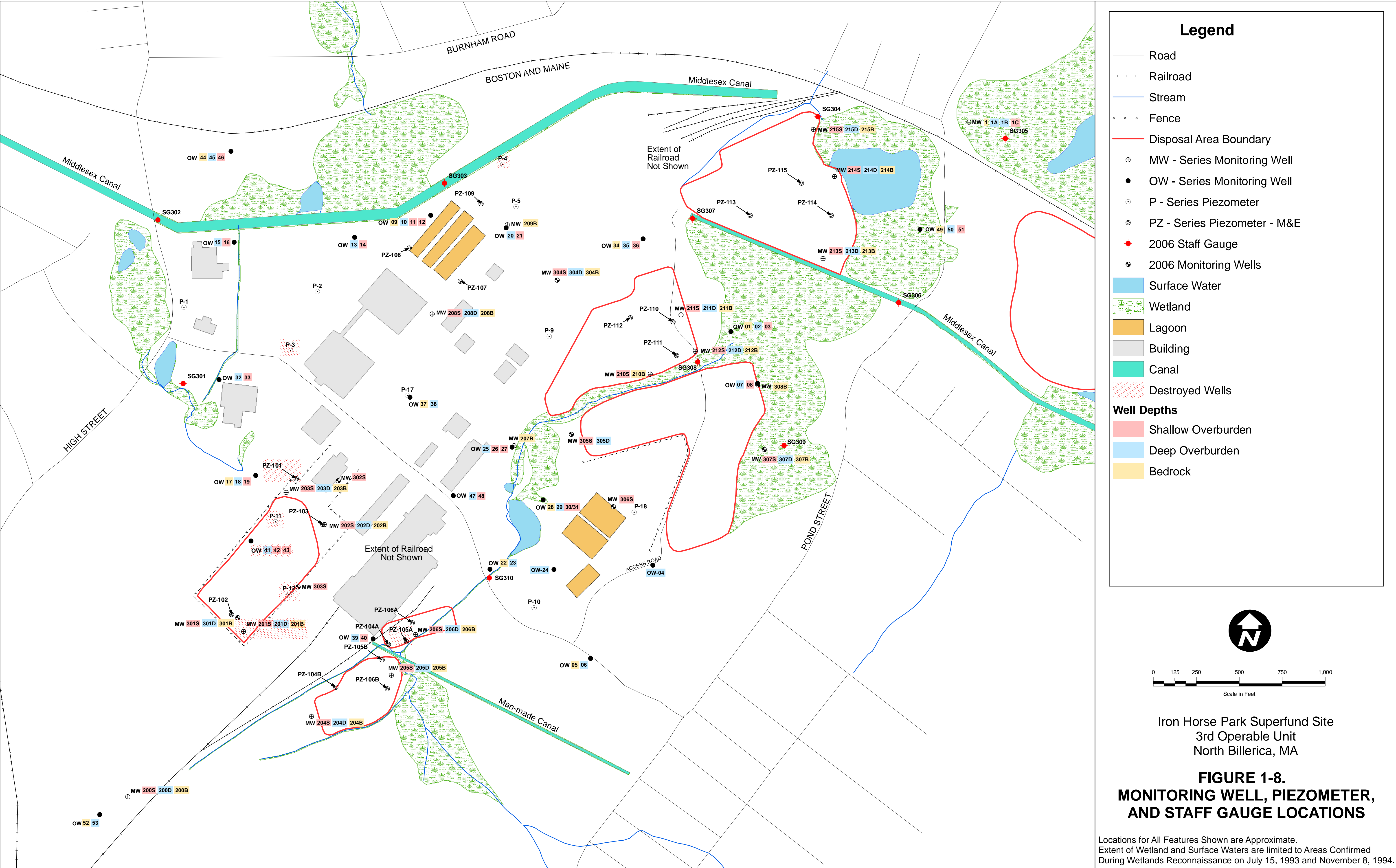
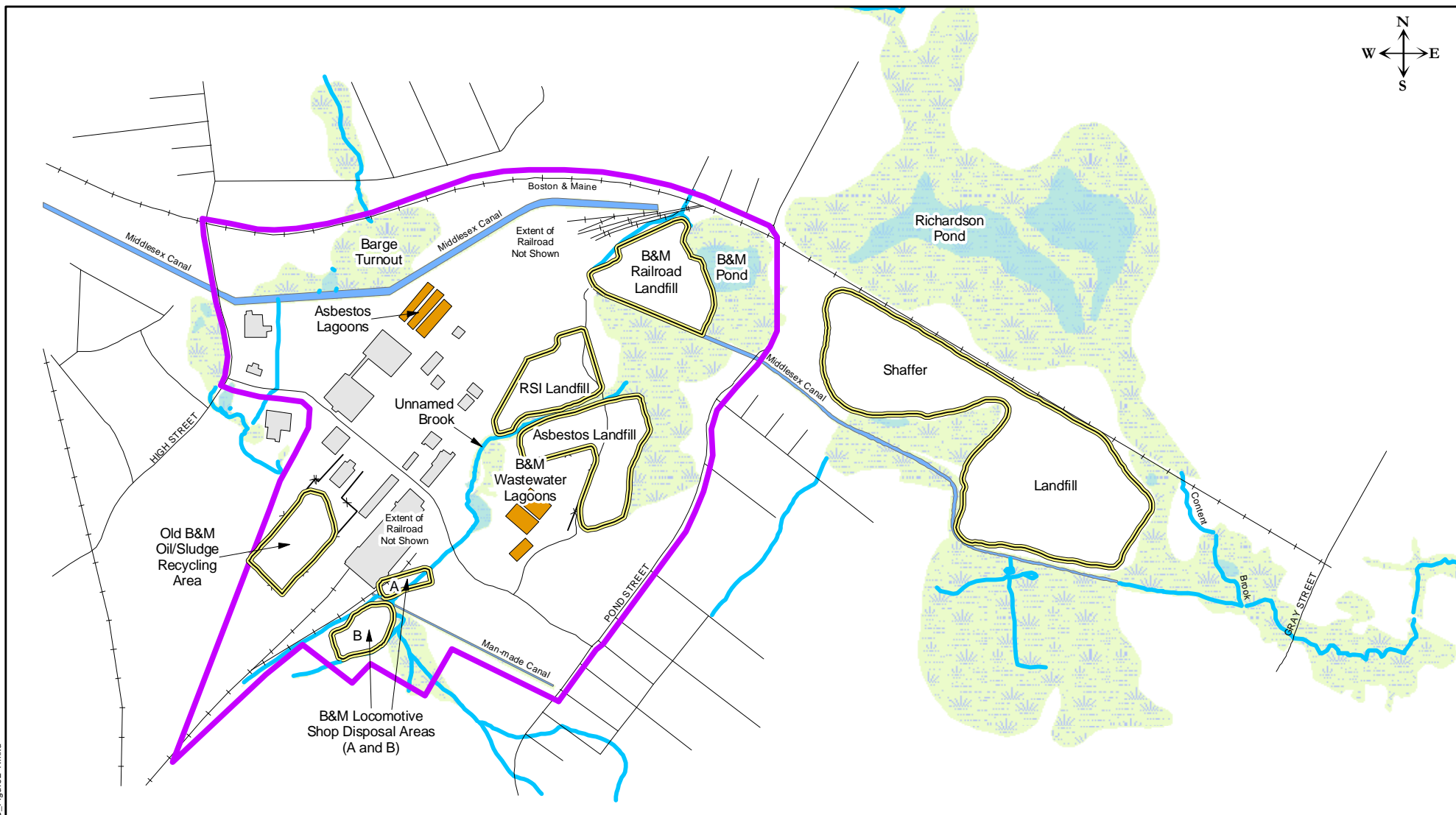


FIGURE 1-7.

2004 ERA/WRIA SEDIMENT, SURFACE WATER, AND FISH SAMPLING LOCATIONS FOR LABORATORY ANALYSIS

Iron Horse Park Superfund Site
4th Operable Unit
North Billerica, MA





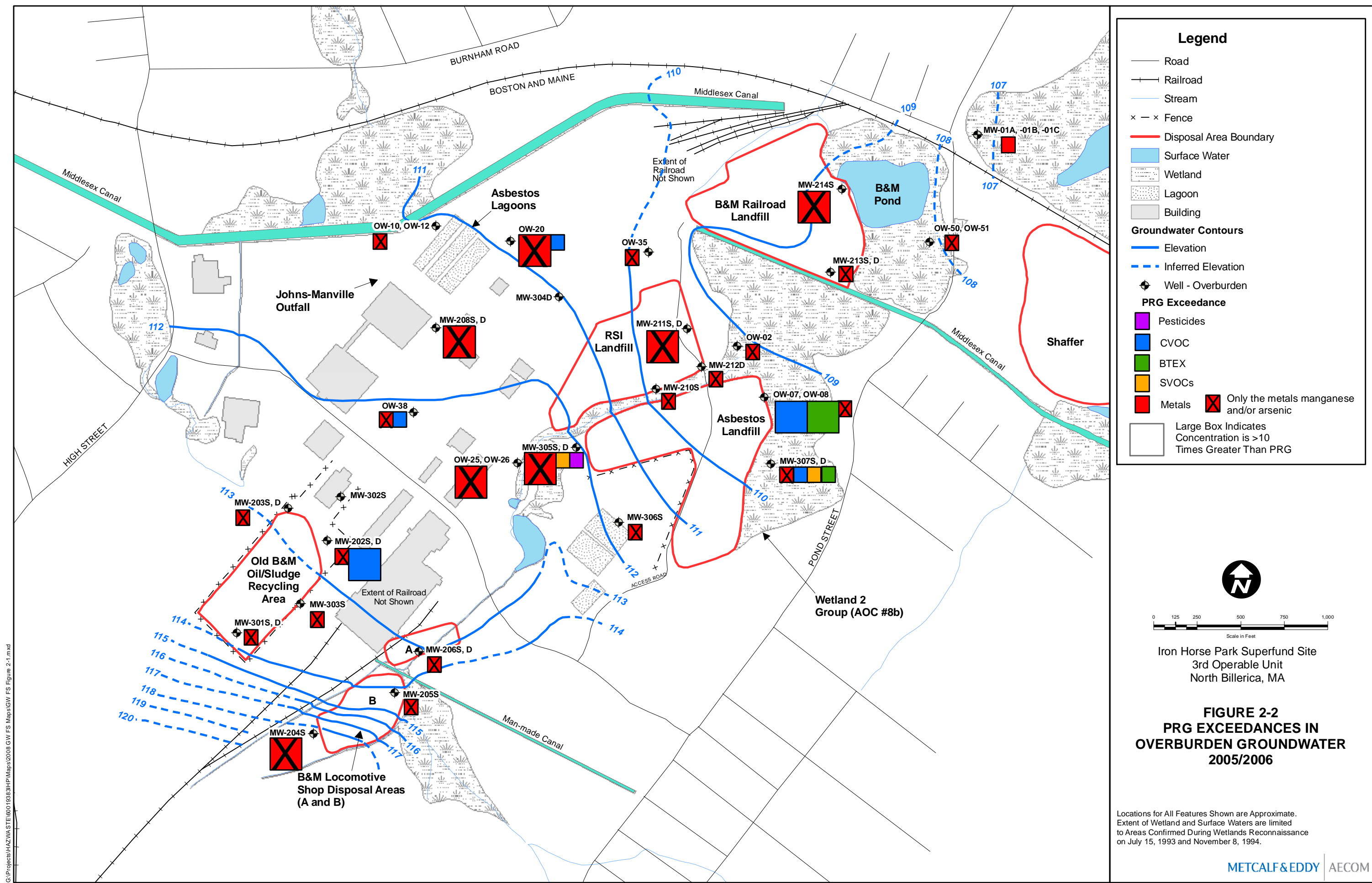
LEGEND

- | | | |
|--------------------------|----------------------------|------------|
| — Road | — Compliance Zone Boundary | ■ Building |
| — Railroad | ■ Surface Water | ■ Canal |
| — Stream | ■ Lagoon | ■ Wetland |
| — Fence | | |
| — Disposal Area boundary | | |

FIGURE 2-1.

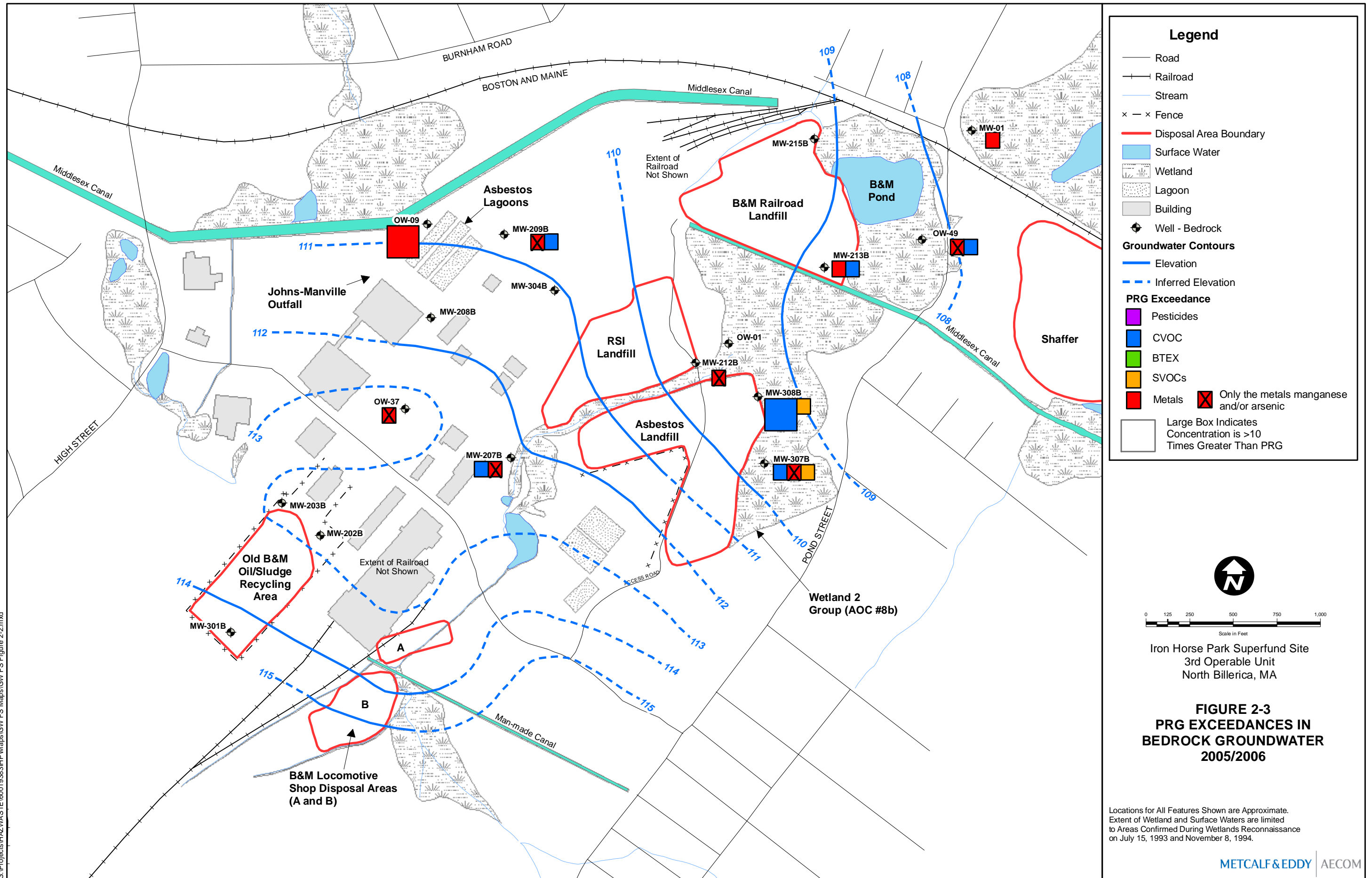
PRELIMINARY GROUNDWATER COMPLIANCE ZONE BOUNDARY

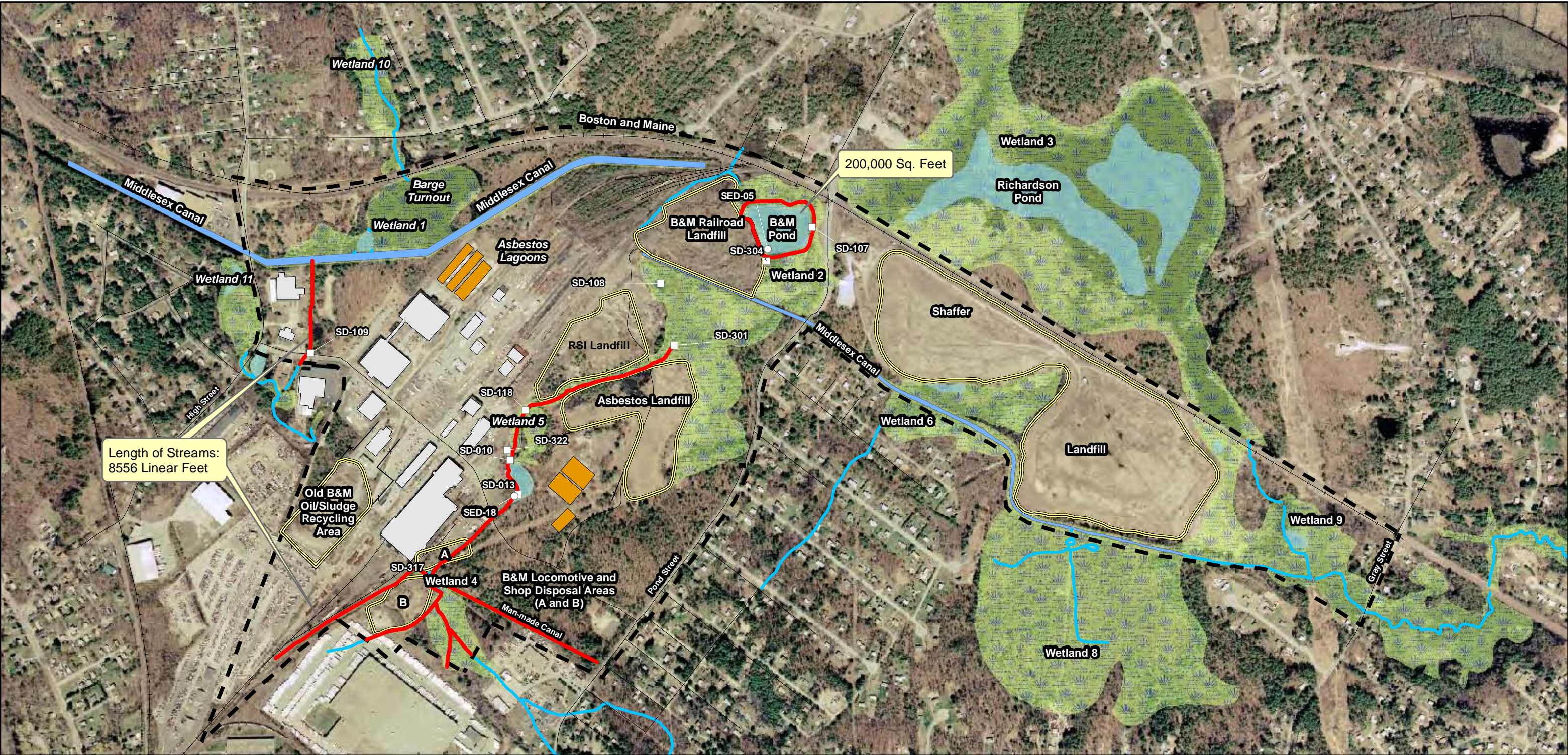
Iron Horse Park Superfund Site
North Billerica, MA



G:\Projects\HAZWASTE\0019383\HP\Maps\2008 GW FS Maps\GW FS Figure 2-1.mxd

G:\Projects\HAZWASTE\60019383\HP\Maps\GW FS Maps\GW FS Figure 2-2.mxd





Road

Railroad

Stream

Fence

Disposal Area boundary

Iron Horse Site Boundary

Extent of Sediment Potentially Requiring Remediation

Surface Water

Lagoon

Building

Canal

Wetland

1993 Sediment Sampling Location

2004 Sediment Sampling Location

N

W

E

S

0

200

400

800

1,200

1,600

Feet

Locations for All Features Shown are Approximate. Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

FIGURE 2-4.

ASSUMED EXTENT OF SEDIMENT POTENTIALLY REQUIRING REDMEDIATION

Iron Horse Park Superfund Site
North Billerica, MA

APPENDIX A

PRG DEVELOPMENT

A-1 GROUNDWATER

TABLE 1
RISK SUMMARY
REASONABLE MAXIMUM EXPOSURE
IRON HORSE PARK SUPERFUND SITE - OU4

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Young Child/Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk Young Child + Adult					Non-Carcinogenic Hazard Quotient Young Child					
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total	
Groundwater	Groundwater	Site-Wide (Overburden and Bedrock Combined)	1,2-Dichloroethane	4E-05	2E-05	2E-06	--	6E-05	Immune System	1E+00	3E-01	1E-01	2E+00	
			1,4-Dichlorobenzene	3E-06	N/A	2E-06	--	5E-06						
			Benzene	6E-05	2E-05	7E-06	--	8E-05						
			Carbon Tetrachloride	3E-04	6E-05	6E-05	--	4E-04						
			cis-1,3-Dichloropropene	2E-05	1E-06	1E-06	--	2E-05	Liver	2E+01	4E-01	3E+00	2E+01	
			Tetrachloroethene	4E-04	8E-06	2E-04	--	6E-04						
			Trichloroethene	5E-04	3E-04	7E-05	--	9E-04						
			Vinyl Chloride	7E-05	7E-07	2E-06	--	7E-05						
			3-Nitroaniline	2E-06	--	6E-08	--	2E-06	N/A	2E+00	--	4E-02	2E+00	
			Atrazine	7E-06	--	8E-07	--	8E-06						
			Bis(2-chloroethyl)ether	1E-05	7E-07	3E-07	--	1E-05						
			Dibenz(a,h)anthracene	6E-06	--	N/A	--	6E-06						
			Dieldrin	4E-06	--	2E-06	--	6E-06	Skin Kidney Blood CNS Kidney	9E+01 4E+00 2E+00 9E+01 2E+00	-- -- -- -- --	4E-01 4E-01 3E-03 1E+01 3E-01	9E+01 5E+00 2E+00 1E+02 2E+00	
			Arsenic	7E-03	--	4E-05	--	7E-03						
			Cadmium (drinking water)											
			Cobalt											
			Manganese (drinking water)											
			Vanadium											
			Chemical Total	9E-03	4E-04	4E-04	--	1E-02		2E+02	9E-01	2E+01	2E+02	
			Radionuclide Total											
			Exposure Point Total							1E-02				
		Exposure Medium Total							1E-02					2E+02
Medium Total							1E-02					2E+02		
Receptor Total							1E-02					2E+02		

-- = Not Evaluated
N/A = Not Applicable

Total Risk Across All Media

1E-02

Total Hazard Across All Media

2E+02

Total Blood HI = 2E+00
Total Cardiovascular HI = N/A
Total Reproductive HI = N/A
Total General Toxicity HI = N/A
Total GI System HI = N/A
Total Immune System HI = 2E+00
Total Kidney HI = 6E+00
Total Liver HI = 5E+01
Total CNS HI = 1E+02
Total Skin HI = 9E+01
Total Eye HI = N/A
Total Respiratory HI = N/A
Total Developmental HI = N/A

TABLE 2
VALUES USED FOR DAILY INTAKE CALCULATIONS
REASONABLE MAXIMUM EXPOSURE
IRON HORSE PARK SUPERFUND SITE - OU4

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion/Dermal/ Inhalation	Resident	Adult/Young Child	Site-Wide (Overburden and Bedrock Combined)	IR _A	Ingestion Rate of Water - adult	2	liters/day	USEPA, 1997a	Preliminary Remediation Goal (PRG) cancer = $\frac{TR \times AT-C}{EF \times CF1 \times (SF_o (IF) + SF_d \times EV \times DF \times CF2 \times CF3 + UR (InhF))}$ where $IF = \frac{IR_A \times ED_A}{BW_A} + \frac{IR_C \times ED_C}{BW_C}$ $DF = \frac{DA_A \times SA_A \times ED_A}{BW_A} + \frac{DA_C \times SA_C \times ED_C}{BW_C}$ $InhF = \text{Determined through air modeling (see HHRA)}$ Preliminary Remediation Goal (PRG) non-cancer = $\frac{THQ \times AT-N}{EF \times CF1 \times ED_C} \times \left[\frac{RfD_c \times BW_C}{IR_C} + RfC \times InhF + \frac{RfD_d \times BW_C}{EV \times SA_C \times DA_C \times CF2 \times CF3} \right]$ where $InhF = \text{Determined through air modeling (see HHRA)}$
				EF	Exposure Frequency	350	days/year	USEPA, 1994a	
				ED _A	Exposure Duration - adult	24	years	USEPA, 1994a	
				BW _A	Body Weight - adult	70	kg	USEPA, 1997a	
				AT-C	Averaging Time (Cancer)	25550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2190	days	USEPA, 1989	
				CF1	Conversion Factor 1	0.001	mg/ug	--	
				BW _C	Body Weight - child	15	kg	USEPA, 1997a	
				IR _C	Ingestion Rate of Water - child	1.5	liters/day	USEPA, 1997a	
				RfD _o	Oral Reference Dose	see Table 3	mg/kg-day	--	
				RfD _d	Dermal Reference Dose	see Table 3	mg/kg-day	--	
				RfC	Inhalation Reference Concentration	see Table 4	ug/m ³	--	
				CF2	Conversion Factor 2	0.001	cm ³ /mg	--	
				CF3	Conversion Factor 3	0.001	liters/cm ³	--	
				EV	Event Frequency	1.0E+00	events/day	USEPA, 2004a	
				THQ	Target Hazard Quotient	1	--	--	
				ED _C	Exposure Duration - child	6	years	USEPA, 1994a	
				SF _o	Oral Slope Factor	see Table 5	(mg/kg-day) ⁻¹	--	
				TR	Target ILCR	10 ⁻⁶ to 10 ⁻⁴	--	--	
				SF _d	Dermal Slope Factor	see Table 5	(mg/kg-day) ⁻¹	--	
				UR	Unit Risk	see Table 6	(ug/m ³) ⁻¹	--	
				DA	Dose Absorbed per Unit Area per Event	see Table 7	mg/cm ² -event	USEPA, 2004a	
				SA _A	Skin Surface Area Available for Contact - adult	18000	cm ²	USEPA, 2004a	
				SA _C	Skin Surface Area Available for Contact - child	6600	cm ²	USEPA, 2004a	

TABLE 3
NON-CANCER TOXICITY DATA -- ORAL/DERMAL
IRON HORSE PARK SUPERFUND SITE - OU4

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD		Oral Absorption Efficiency for Dermal (1)	Absorbed RfD for Dermal		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfD:Target Organ(s)	
		Value	Units		Value	Units			Source(s)	Date(s) (MM/DD/YYYY)
1,2-Dichloroethane	Chronic	2E-02	mg/kg-day	(4)	2E-02	mg/kg-day	Kidney	3000	STSC	01/05/05
1,4-Dichlorobenzene	Chronic	3E-02	mg/kg-day	(4)	3E-02	mg/kg-day	Developmental	1000	STSC	01/05/05
Benzene	Chronic	4E-03	mg/kg-day	(4)	4E-03	mg/kg-day	Immune System	300	IRIS	10/13/06
Carbon tetrachloride	Chronic	7E-04	mg/kg-day	(4)	7E-04	mg/kg-day	Liver	1000	IRIS	10/13/06
cis-1,3-Dichloropropene	Chronic	3E-02	mg/kg-day	(4)	3E-02	mg/kg-day	GI System	100	IRIS	10/13/06
Tetrachloroethene	Chronic	1E-02	mg/kg-day	(4)	1E-02	mg/kg-day	Liver	1000	IRIS	10/13/06
Trichloroethene	Chronic	3E-04	mg/kg-day	(4)	3E-04	mg/kg-day	Liver	3000	STSC	01/05/05
Vinyl Chloride	Chronic	3E-03	mg/kg-day	(4)	3E-03	mg/kg-day	Liver	30	IRIS	10/13/06
3-Nitroaniline	Chronic	3E-04	mg/kg-day	(4)	3E-04	mg/kg-day	N/A	N/A	STSC	01/05/05
Atrazine	Chronic	3.5E-02	mg/kg-day	(4)	3.5E-02	mg/kg-day	General Toxicity/Cardiovascular	100	IRIS	10/13/06
Bis(2-chloroethyl)ether	Chronic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dibenz(a,h)anthracene	Chronic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dieldrin	Chronic	5E-05	mg/kg-day	(4)	5E-05	mg/kg-day	Liver	100	IRIS	10/13/06
Arsenic	Chronic	3E-04	mg/kg-day	(4)	3E-04	mg/kg-day	Skin	3	IRIS	10/13/06
Cadmium (drinking water)	Chronic	5E-04	mg/kg-day	0.05	2.5E-05	mg/kg-day	Kidney	10	IRIS	10/13/06
Cobalt	Chronic	2E-02	mg/kg-day	(4)	2E-02	mg/kg-day	Blood	1	STSC	01/05/05
Manganese (drinking water)	Chronic	2.4E-02	mg/kg-day	0.04	9.6E-04	mg/kg-day	CNS	9	IRIS	10/13/06
Vanadium	Chronic	1E-03	mg/kg-day	0.026	2.6E-05	mg/kg-day	Kidney	300	STSC	01/05/05

(1) Oral absorption efficiencies from RAGS, Part E (USEPA, 2004a).

(2) Calculated as: (oral RfD) x (oral to dermal adjustment factor).

(3)

RfDs for manganese are based on total allowable intake (10 mg/day) minus the background intake (5 mg/day). The remaining intake (5 mg/day) is divided by 70 kg.

(4) Oral absorption efficiency exceeds 50%. No adjustment of the oral reference dose is necessary.

(5) Permeability constants (Kp) used for water absorption calculations: 4E-04 cm/hr for cobalt and 1E-03 cm/hr for the remaining inorganics (USEPA, 2004a); for organics, see Table 7.

IRIS = Integrated Risk Information System

STSC = Superfund Technical Support Center

N/A = Not Applicable

TABLE 4
NON-CANCER TOXICITY DATA -- INHALATION
IRON HORSE PARK SUPERFUND SITE - OU4

Chemical of Potential Concern	Chronic/ Subchronic	Inhalation RfC		Extrapolated RfD ⁽¹⁾		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfC : Target Organ(s)	
		Value	Units	Value	Units			Source(s)	Date(s) (MM/DD/YYYY)
1,2-Dichloroethane	Chronic	5E+00	ug/m ³	N/A	N/A	Liver/Kidney/GI System	3000	STSC	01/05/05
1,4-Dichlorobenzene	Chronic	8E+02	ug/m ³	N/A	N/A	Liver	100	IRIS	10/13/06
Benzene	Chronic	3E+01	ug/m ³	N/A	N/A	Immune System	300	IRIS	10/13/06
Carbon tetrachloride	Chronic	4.0E+01	ug/m ³	N/A	N/A	GI System/ Developmental/CNS	N/A	CalEPA	10/13/06
cis-1,3-Dichloropropene	Chronic	2E+01	ug/m ³	N/A	N/A	Respiratory	30	IRIS	10/13/06
Tetrachloroethene	Chronic	2.7E+02	ug/m ³	N/A	N/A	CNS	100	ATSDR	01/05/05
Trichloroethene	Chronic	4E+01	ug/m ³	N/A	N/A	Liver/CNS	3000	STSC	01/05/05
Vinyl Chloride	Chronic	1E+02	ug/m ³	N/A	N/A	Liver	30	IRIS	10/13/06
Bis(2-chloroethyl)ether	Chronic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

IRIS = Integrated Risk Information System

HEAST = Health Effects Assessment Summary Tables

STSC = Superfund Technical Support Center

CalEPA = California Environmental Protection Agency, Office of Environmental
Health Hazard Assessment

ATSDR = Agency for Toxic Substances and Disease Registry

N/A = Not Applicable

TABLE 5
CANCER TOXICITY DATA -- ORAL/DERMAL
IRON HORSE PARK SUPERFUND SITE - OU4

Chemical of Potential Concern	Oral Cancer Slope Factor		Oral Absorption Efficiency for Dermal	Absorbed Cancer Slope Factor for Dermal		Weight of Evidence/ Cancer Guideline Description	Oral CSF	
	Value	Units		Value	Units		Source(s)	Date(s) (MM/DD/YYYY)
			(1)					
1,2-Dichloroethane	9.1E-02	(mg/kg-day) ⁻¹	(1)	9.1E-02	(mg/kg-day) ⁻¹	B2	IRIS	10/13/06
1,4-Dichlorobenzene	2.4E-02	(mg/kg-day) ⁻¹	(1)	2.4E-02	(mg/kg-day) ⁻¹	C	HEAST	July 1997
Benzene	5.5E-02	(mg/kg-day) ⁻¹	(1)	5.5E-02	(mg/kg-day) ⁻¹	A	IRIS	10/13/06
Carbon tetrachloride	1.3E-01	(mg/kg-day) ⁻¹	(1)	1.3E-01	(mg/kg-day) ⁻¹	B2	IRIS	10/13/06
cis-1,3-Dichloropropene	1.0E-01	(mg/kg-day) ⁻¹	(1)	1.0E-01	(mg/kg-day) ⁻¹	B2	IRIS	10/13/06
Tetrachloroethene	5.4E-01	(mg/kg-day) ⁻¹	(1)	5.4E-01	(mg/kg-day) ⁻¹	B2	CalEPA	01/05/05
Trichloroethene	4E-01	(mg/kg-day) ⁻¹	(1)	4E-01	(mg/kg-day) ⁻¹	C-B2	STSC	01/05/05
Vinyl Chloride	7.5E-01	(mg/kg-day) ⁻¹	(1)	7.5E-01	(mg/kg-day) ⁻¹	A	IRIS	10/13/06
3-Nitroaniline	2.1E-02	(mg/kg-day) ⁻¹	(1)	2.1E-02	(mg/kg-day) ⁻¹	N/A	STSC	01/05/05
Atrazine	2.2E-01	(mg/kg-day) ⁻¹	(1)	2.2E-01	(mg/kg-day) ⁻¹	C	HEAST	July 1997
Bis(2-chloroethyl)ether	1.1E+00	(mg/kg-day) ⁻¹	(1)	1.1E+00	(mg/kg-day) ⁻¹	B2	IRIS	10/13/06
Dibenz(a,h)anthracene	7.3E+00	(mg/kg-day) ⁻¹	(1)	7.3E+00	(mg/kg-day) ⁻¹	B2	IRIS	10/13/06
Dieldrin	1.6E+01	(mg/kg-day) ⁻¹	(1)	1.6E+01	(mg/kg-day) ⁻¹	B2	IRIS	10/13/06
Arsenic	1.5E+00	(mg/kg-day) ⁻¹	(1)	1.5E+00	(mg/kg-day) ⁻¹	A	IRIS	10/13/06
Cadmium (drinking water)	N/A	N/A	N/A	N/A	N/A	D	IRIS	10/13/06
Cobalt	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese (drinking water)	N/A	N/A	N/A	N/A	N/A	D	IRIS	10/13/06
Vanadium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

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N/A = Not Applicable

Slope factor for benzo(a)pyrene, along with the appropriate relative potency factor
(USEPA, 1993), used for the other carcinogenic PAHs.

(1) Oral absorption efficiency exceeds 50%. Therefore, no adjustment of the oral slope factor is necessary.

(2) Calculated as: (oral slope factor) / (oral to dermal adjustment factor)

Benzene has range of values: high-end = 0.055, low-end = 0.015

Trichloroethene has range of values: high-end = 0.4, low-end = 0.2, CalEPA = 0.013

EPA Group:

A - Human carcinogen

B1 - Probable human carcinogen - indicates that limited human data are available

B2 - Probable human carcinogen - indicates sufficient evidence in animals and
inadequate or no evidence in humans

C - Possible human carcinogen

D - Not classifiable as a human carcinogen (by the oral route)

E - Evidence of noncarcinogenicity

TABLE 6
CANCER TOXICITY DATA -- INHALATION
IRON HORSE PARK SUPERFUND SITE - OU4

Chemical of Potential Concern	Unit Risk		Inhalation Cancer Slope Factor		Weight of Evidence/ Cancer Guideline Description	Unit Risk : Inhalation CSF	
	Value	Units	Value	Units		Source(s)	Date(s) (MM/DD/YYYY)
1,2-Dichloroethane	2.6E-05	(ug/m ³) ⁻¹	N/A	N/A	B2	IRIS	10/13/06
1,4-Dichlorobenzene	N/A	N/A	N/A	N/A	C	HEAST	July 1997
Benzene	7.8E-06	(ug/m ³) ⁻¹	N/A	N/A	A	IRIS	10/13/06
Carbon tetrachloride	1.5E-05	(ug/m ³) ⁻¹	N/A	N/A	B2	IRIS	10/13/06
cis-1,3-Dichloropropene	4.0E-06	(ug/m ³) ⁻¹	N/A	N/A	B2	IRIS	10/13/06
Tetrachloroethene	5.9E-06	(ug/m ³) ⁻¹	N/A	N/A	B2	CalEPA	01/05/05
Trichloroethene	1.1E-04	(ug/m ³) ⁻¹	N/A	N/A	C-B2	STSC	01/05/05
Vinyl Chloride	4.4E-06	(ug/m ³) ⁻¹	N/A	N/A	A	IRIS	10/13/06
Bis(2-chloroethyl)ether	3.3E-04	(ug/m ³) ⁻¹	N/A	N/A	B2	IRIS	10/13/06

IRIS = Integrated Risk Information System

STSC = Superfund Technical Support Center

CalEPA = California Environmental Protection Agency, Office of Environmental
Health Hazard Assessment

HEAST = Health Effects Assessment Summary Tables

N/A = Not Applicable

EPA Group:

A - Human carcinogen

B1 - Probable human carcinogen - indicates that limited human data are available

B2 - Probable human carcinogen - indicates sufficient evidence in animals and
inadequate or no evidence in humans

C - Possible human carcinogen

D - Not classifiable as a human carcinogen (by the oral route)

E - Evidence of noncarcinogenicity

Benzene has range of values: high-end = 7.8E-06, low-end = 2.2E-06

Trichloroethene has range of values: high-end = 1.1E-04, low-end = 5.7E-06, CalEPA = 2E-06

TABLE 7. DERMALLY ABSORBED DOSE CALCULATIONS - GROUNDWATER
(Variable Definitions follow Table)

Timeframe	Receptor	Exposure Point	Chemical	Conc ug/L	Conc mg/cm ³	CAS No.	MWT	logKow	Kp (cm/hr) predicted	lsc cm	IR cm ³ /day	ABSGI	B	tau (hr)	FA for tau>3	log(Ds/lsc)	Dsc/lsc	Dsc	b	c	t_star1 B>0.6	t_star3 B<=0.6
Future	Resident - Adult	Site-Wide (OB + BR)	1,2-Dichloroethane	2.3E+01	2.3E-05	107062	99.0	1.48	4.2E-03	1.0E-03	2000	1	0.016	0.38	1.0	-3.35E+00	4.42E-04	4.42E-07	3.1E-01	3.4E-01	N/A	0.90
			1,4-Dichlorobenzene	7.5E+00	7.5E-06	106467	147.0	3.39	4.2E-02	1.0E-03	2000	1	0.196	0.70	1.0	-3.62E+00	2.38E-04	2.38E-07	4.4E-01	4.7E-01	N/A	1.68
			Benzene	5.9E+01	5.9E-05	71432	78.1	2.13	1.5E-02	1.0E-03	2000	1	0.051	0.29	1.0	-3.24E+00	5.79E-04	5.79E-07	3.3E-01	3.7E-01	N/A	0.69
			Carbon Tetrachloride	1.2E+02	1.2E-04	56235	153.8	2.83	1.6E-02	1.0E-03	2000	1	0.078	0.76	1.0	-3.66E+00	2.18E-04	2.18E-07	3.5E-01	3.9E-01	N/A	1.83
			cis-1,3-Dichloropropene	8.6E+00	8.6E-06	10061015	111.0	1.98	7.7E-03	1.0E-03	2000	1	0.031	0.44	1.0	-3.42E+00	3.79E-04	3.79E-07	3.2E-01	3.5E-01	N/A	1.06
			Tetrachloroethene	3.9E+01	3.9E-05	127184	165.8	3.40	3.3E-02	1.0E-03	2000	1	0.166	0.89	1.0	-3.73E+00	1.87E-04	1.87E-07	4.1E-01	4.5E-01	N/A	2.14
			Trichloroethene	7.5E+01	7.5E-05	79016	131.4	2.42	1.2E-02	1.0E-03	2000	1	0.051	0.57	1.0	-3.54E+00	2.91E-04	2.91E-07	3.4E-01	3.7E-01	N/A	1.37
			Vinyl Chloride	7.4E-01	7.4E-07	75014	62.5	1.36	5.6E-03	1.0E-03	2000	1	0.017	0.24	1.0	-3.15E+00	7.08E-04	7.08E-07	3.1E-01	3.4E-01	N/A	0.57
			3-Nitroaniline	6.2E+00	6.2E-06	99092	138.1	1.37	2.1E-03	1.0E-03	2000	1	0.010	0.62	1.0	-3.57E+00	2.67E-04	2.67E-07	3.1E-01	3.4E-01	N/A	1.50
			Atrazine	1.9E+00	1.9E-06	1912249	215.7	2.61	5.2E-03	1.0E-03	2000	1	0.030	1.70	1.0	-4.01E+00	9.82E-05	9.82E-08	3.2E-01	3.5E-01	N/A	4.07
			Bis(2-chloroethyl)ether	7.0E-01	7.0E-07	111444	143.0	1.29	1.8E-03	1.0E-03	2000	1	0.008	0.66	1.0	-3.60E+00	2.51E-04	2.51E-07	3.1E-01	3.4E-01	N/A	1.60
			Dieldrin	1.3E-02	1.3E-08	60571	381.0	4.56	1.2E-02	1.0E-03	2000	1	0.092	14.30	0.8	-4.93E+00	1.17E-05	1.17E-08	3.6E-01	4.0E-01	N/A	34.33
Future	Resident - Child	Site-Wide (OB + BR)	1,2-Dichloroethane	2.3E+01	2.3E-05	107062	99.0	1.48	4.2E-03	1.0E-03	2000	1	0.016	0.38	1.0	-3.35E+00	4.42E-04	4.42E-07	3.1E-01	3.4E-01	N/A	0.90
			1,4-Dichlorobenzene	7.5E+00	7.5E-06	106467	147.0	3.39	4.2E-02	1.0E-03	2000	1	0.196	0.70	1.0	-3.62E+00	2.38E-04	2.38E-07	4.4E-01	4.7E-01	N/A	1.68
			Benzene	5.9E+01	5.9E-05	71432	78.1	2.13	1.5E-02	1.0E-03	2000	1	0.051	0.29	1.0	-3.24E+00	5.79E-04	5.79E-07	3.3E-01	3.7E-01	N/A	0.69
			Carbon Tetrachloride	1.2E+02	1.2E-04	56235	153.8	2.83	1.6E-02	1.0E-03	2000	1	0.078	0.76	1.0	-3.66E+00	2.18E-04	2.18E-07	3.5E-01	3.9E-01	N/A	1.83
			cis-1,3-Dichloropropene	8.6E+00	8.6E-06	10061015	111.0	1.98	7.7E-03	1.0E-03	2000	1	0.031	0.44	1.0	-3.42E+00	3.79E-04	3.79E-07	3.2E-01	3.5E-01	N/A	1.06
			Tetrachloroethene	3.9E+01	3.9E-05	127184	165.8	3.40	3.3E-02	1.0E-03	2000	1	0.166	0.89	1.0	-3.73E+00	1.87E-04	1.87E-07	4.1E-01	4.5E-01	N/A	2.14
			Trichloroethene	7.5E+01	7.5E-05	79016	131.4	2.42	1.2E-02	1.0E-03	2000	1	0.051	0.57	1.0	-3.54E+00	2.91E-04	2.91E-07	3.4E-01	3.7E-01	N/A	1.37
			Vinyl Chloride	7.4E-01	7.4E-07	75014	62.5	1.36	5.6E-03	1.0E-03	2000	1	0.017	0.24	1.0	-3.15E+00	7.08E-04	7.08E-07	3.1E-01	3.4E-01	N/A	0.57
			3-Nitroaniline	6.2E+00	6.2E-06	99092	138.1	1.37	2.1E-03	1.0E-03	2000	1	0.010	0.62	1.0	-3.57E+00	2.67E-04	2.67E-07	3.1E-01	3.4E-01	N/A	1.50
			Atrazine	1.9E+00	1.9E-06	1912249	215.7	2.61	5.2E-03	1.0E-03	2000	1	0.030	1.70	1.0	-4.01E+00	9.82E-05	9.82E-08	3.2E-01	3.5E-01	N/A	4.07
			Bis(2-chloroethyl)ether	7.0E-01	7.0E-07	111444	143.0	1.29	1.8E-03	1.0E-03	2000	1	0.008	0.66	1.0	-3.60E+00	2.51E-04	2.51E-07	3.1E-01	3.4E-01	N/A	1.60
			Dieldrin	1.3E-02	1.3E-08	60571	381.0	4.56	1.2E-02	1.0E-03	2000	1	0.092	14.30	0.8	-4.93E+00	1.17E-05	1.17E-08	3.6E-01	4.0E-01	N/A	34.33

TABLE 7. DERMALLY ABSORBED DOSE CALCULATIONS - GROUNDWATER

(Variable Definitions follow Table)

Timeframe	Receptor	Exposure Point	Chemical	t_star (hr)	A cm ²	t_event hr/event	EV event/day	DA_event mg/cm2-evt	Derm/Drink Kp	Chem Assess
Future	Resident - Adult	Site-Wide (OB + BR)	1,2-Dichloroethane	0.90	18000	0.58	1	1.2E-07	5%	N
			1,4-Dichlorobenzene	1.68	18000	0.58	1	5.5E-07	67%	Y
			Benzene	0.69	18000	0.58	1	9.9E-07	15%	Y
			Carbon Tetrachloride	1.83	18000	0.58	1	3.6E-06	27%	Y
			cis-1,3-Dichloropropene	1.06	18000	0.58	1	9.3E-08	10%	N
			Tetrachloroethene	2.14	18000	0.58	1	2.6E-06	60%	Y
			Trichloroethene	1.37	18000	0.58	1	1.4E-06	17%	Y
			Vinyl Chloride	0.57	18000	0.58	1	4.3E-09	5%	N
			3-Nitroaniline	1.50	18000	0.58	1	2.2E-08	3%	N
			Atrazine	4.07	18000	0.58	1	2.7E-08	13%	Y
			Bis(2-chloroethyl)ether	1.60	18000	0.58	1	2.1E-09	3%	N
			Dieldrin	34.33	18000	0.58	1	1.0E-09	70%	Y
Future	Resident - Child	Site-Wide (OB + BR)	1,2-Dichloroethane	0.90	6600	1	1	1.7E-07	2%	N
			1,4-Dichlorobenzene	1.68	6600	1	1	7.3E-07	32%	Y
			Benzene	0.69	6600	1	1	1.4E-06	8%	N
			Carbon Tetrachloride	1.83	6600	1	1	4.7E-06	13%	Y
			cis-1,3-Dichloropropene	1.06	6600	1	1	1.2E-07	5%	N
			Tetrachloroethene	2.14	6600	1	1	3.4E-06	29%	Y
			Trichloroethene	1.37	6600	1	1	1.8E-06	8%	N
			Vinyl Chloride	0.57	6600	1	1	6.1E-09	3%	N
			3-Nitroaniline	1.50	6600	1	1	2.9E-08	2%	N
			Atrazine	4.07	6600	1	1	3.6E-08	6%	N
			Bis(2-chloroethyl)ether	1.60	6600	1	1	2.8E-09	1%	N
			Dieldrin	34.33	6600	1	1	1.3E-09	34%	Y

DERMAL ABSORPTION CALCULATION EXAMPLE

Note: This EPA spreadsheet utilized as basis for Table 7 calculations.

FOR ORGANIC CHEMICALS IN WATER (updated on 11/99)

Worksheet to Calculate Dermal Absorption of Organic Chemicals from Aqueous Media (updated 11/99)

Enter the Following Exposure Conditions: for site specific conditions, change values in Cells G5-G18

Concentration (mg/L*L/1000 cm3):	Conc =	1.0E-03 mg/cm3 (default value for purpose of illustration)
Input site specific concentrations in Column marked "Conc"		= 1 mg/L (1 ppm) = 1 ug/cm3 = 1000 ppb
Area exposed (cm2):	A =	5672.0 cm2
Event time (hr/event):	t_event =	0.5 hr/event (35 minutes/event)
Event frequency (events/day):	EV =	1.0 event/day
Exposure frequency (days/year):	EF =	26.0 days/yr
Exposure duration (years):	ED =	7.0 years
Body weight (kg):	BW =	70.0 kg
Averaging time (days):	AT =	2555.0 days
for carcinogenic effects, AT=70 years (25,550 days)		
for noncarcinogenic effects, AT=ED (in days)		
Skin thickness (assumed to be 10 um):	lsc =	1.0E-03 cm

Default conditions for screening purposes:

Compare Dermal to Drinking: Adults showering for 35 minutes/day, compared to drinking 2L water/day

Dermal (mg/day) = DA_event * A * EV	IR =	2000.0 (cm3/day = L/day * 1000 cm3/L)
Drinking (mg/day) = Conc * IR * ABSIG	ABSGI =	1.0 (assumed 100% GI absorption)

IR: Ingestion rate of drinking water
 ABSIG: Absorption fraction in GI tract

Refer to Appendix A for equations to evaluate DA_event and DAD

(*): outside of the Effective Prediction Domain (EPD) determined by the Flynn's measured Kp data

95% LCI and UCI are evaluated by Dr. Paul Pinsky in NCEA using SAS

CHEMICAL	CAS No.	MWT	logKow	Kp 95% LCI	Kp (cm/hr) predicted	Kp (cm/hr) measured	Kp 95% UCI	Chemicals outside EPD (*)	Derm/ Drink Kp	Chem Assess	B	tau (hr)	t_star (hr)
118 Heptachlor	76448	373.5	4.27	3.4E-04	8.6E-03		2.2E-01		14%	Y	0.1	12.99	31.16
	FA for tau>3	Conc (mg/cm3)	DA_event (mg/cm2-evt)	DAD (mg/kg-day)		log(Ds/lsc)	Dsc/lsc	Dsc		b	c	t_star1 B>0.6	t_star3 B<=0.6
	0.8	1.4E-09	6.8E-11	3.9E-10		-4.89E+00	1.28E-05	1.28E-08		3.4E-01	3.8E-01	#NUM!	31.16

TABLE 8. HUMAN HEALTH PRELIMINARY REMEDIATION GOALS (PRGs)

Media/ Scenario	COC	Maximum Detection	Regulatory Criteria ¹		Risk-Based PRGs - Ingestion/Dermal/Inhalation ²				Additional Information				Selected PRG	Basis	
			Federal MCLs	MassDEP MCLs	ILCR			HQ = 1	Site-specific Range of Background Levels ³	MassDEP Background ⁴	Health Advisory ⁵	PQL			
					10 ⁻⁶	10 ⁻⁵	10 ⁻⁴								
Groundwater - ug/L (Residential Scenario)	1,2-Dichloroethane	23	5	5	0.39	3.9	39	N/A	--	--	--	0.1	5	MCL	
	1,4-Dichlorobenzene	7.5	75	5	1.5	15	150	6828	--	--	--	0.5	5	MMCL	
	Benzene	59	5	5	0.70	7.0	70	32	--	--	--	0.5	5	MCL	
	Carbon tetrachloride	120	5	5	0.30	3.0	30	6.1	--	--	--	0.1	5	MCL	
	cis-1,3-Dichloropropene	8.6	--	--	0.49	4.9	49	101	--	--	--	0.1	0.49	ILCR = 10 ⁻⁶	
	Tetrachloroethene	39	5	5	0.069	0.69	6.9	73	--	--	--	0.05	5		MCL
	Trichloroethene	75	5	5	0.083	0.83	8.3	2.8	--	--	--	0.05	5		MCL
	Vinyl chloride	0.74	2	2	0.011	0.11	1.1	29	--	--	--	0.05	2		MCL
	Atrazine	1.9	3	3	0.23	2.3	23	337	--	--	--	1	3	MCL	
	Bis(2-chloroethyl)ether	0.7	--	--	0.048	0.48	4.8	N/A	--	--	--	0.5	0.5	PQL	
	Dibenz(a,h)anthracene	0.05	--	--	0.0078	0.078	0.78	N/A	--	--	--	0.1	0.1	PQL	
	Dieldrin	0.013	--	--	0.0022	0.022	0.22	0.36	--	--	--	0.01	0.01	PQL	
	Arsenic	281	10	10	0.038	0.38	3.8	3.1	7.9 - 48.5	5.5	--	0.5	10	MCL	
	Cadmium	22.3	5	5	N/A	N/A	N/A	4.8	--	4.2	--	1	5	MCL	
	Lead ⁶	29	15	15	N/A	N/A	N/A	N/A	12.5	8.8	--	1	15	MCL	
	Manganese	22600	--	--	N/A	N/A	N/A	225	14.5 - 1180	--	300	1	300	Health Adv.	

Notes

COC - Contaminant of Concern

MCL - Maximum Contaminant Level

MMCL - Massachusetts Maximum Contaminant Level

ILCR - Incremental Lifetime Cancer Risk

HQ - Hazard Quotient

N/A - Not carcinogenic, or a carcinogen was not evaluated for potential non-carcinogenic effects

PQL - Practical Quantification Limit; While it may be possible to achieve lower limits, those that are reasonably achievable have been included.

1. Regulatory Criteria only include regulatory requirements considered applicable or relevant and appropriate; -- = no criterion

2. Risk-based PRGs have only been calculated for those COCs shown to drive risk in the supplemental human health risk assessment (M&E, 2008a).

3. Site-specific background concentrations taken from results presented in the RI report (M&E, 1997) for locations (MW-200S/D/B and OW-05) sampled in March/April and July 1995; -- = not detected

4. From *Background Documentation for the Development of the Massachusetts Contingency Plan (MCP) Numerical Standards* (MassDEP, 1994).

5. Health Advisory on Manganese (EPA-822-R-04-003; January 2004); -- = not applicable

6. Lead was identified in the Supplemental HHRA as a risk-driver, however, it was not quantitatively evaluated.

A-2 SEDIMENT

This appendix provides backup information related to the development of sediment Preliminary Remediation Goals (PRGs) at the Iron Horse Park OU-4 site. Initial steps associated with this process were presented in the ERA/WRIA (M&E, 2006a) and are summarized below, followed by further development and selection of site-specific PRGs to be utilized in the Record of Decision (ROD).

Summary of Steps Performed in the ERA/WRIA

The ERA/WRIA established site-specific No Observed Effects Concentrations (NOECs) for each Contaminant of Concern (COC) as shown on Table 1. The NOEC is selected as the largest concentration of a COC detected in whole sediment toxicity tests for which there was no observed toxic effect. Content Brook downstream of the site had toxicity test results that did not exhibit a statistically significant difference from those of the reference sediment in Round Pond. The sediment NOEC used results from both Content Brook and Round Pond reference which had no toxic effect. The NOEC for each COC was selected as the largest concentration detected, or the higher of the two detection limits for non-detect COCs (Table 1 corresponds to Table 7-5 in M&E, 2006a).

All of the NOECs for metals are based on sediment concentrations measured in Content Brook (SED-01). The total PAH NOEC of 1,932 ug/kg is also based on PAH concentrations in Content Brook. NOECs for 4,4'-DDD (14.5 ug/kg), Aroclor-1260 (13.7 ug/kg), and total PCBs (14 ug/kg) are based on sediment concentrations in Round Pond, which had no toxic effect. Aroclor-1242 or Aroclor-1254 concentrations were below detection limits in both Round Pond and Content Brook. NOECs for these COCs were estimated as the higher of the two detection limits (Table 1).

The chemical result of 3.1 ug/kg for 4,4'-DDD at SED-11 (West Middlesex Canal) was rejected during data validation due to interferences in the sample analysis (M&E, 2006a). Since the result was rejected primarily because it could represent a false positive and there was no toxic effect observed (M&E, 2006a), it is reasonable to use the rejected value as an estimated NOEC for 4,4'-DDD in sediment.

Using the site-specific NOECs, three of the metal COCs can be eliminated as contributors to toxicity in any of the site sediment samples. Arsenic, barium, and manganese concentrations at the three sediment sample locations (B&M Pond, Unnamed Brook, and West Middlesex Canal) were all less than their respective NOECs (Table 1).

PRG Refinement

Lowest Observed Effects Concentrations (LOECs) were also selected using site-specific chemistry data, and results of the sediment toxicity tests. The LOEC is the smallest concentration of a COC detected in the toxicity tests for which a toxic effect was observed. Table 2 lists the LOEC values for the remaining sediment COCs. The three sediment locations that showed low or moderate toxicity in the toxicity tests were B&M Pond (SED-05), West Middlesex Canal (SED-11), and Unnamed Brook (SED-18). The smallest of the three values measured in the sediment for each COC was selected as the LOEC for each value above the NOEC. Based on the assumptions of assigning the NOEC values, concentrations below the NOEC are not likely to be responsible for the observed toxicity and therefore do not represent a LOEC.

Table 2 also presents a Maximum Acceptable Toxic Concentration (MATC) that is calculated for each COC. The MATC is conservatively calculated as the geometric mean of the NOEC and the LOEC (survival or growth effects on test organisms). The MATC is a value also derived from site-specific data that represents a concentration of the COC below which ecological risk is “acceptable.”

The results of the ecological risk assessment lead to the calculation of MATC values for the mixture of COCs listed in Table 2 which are selected as Preliminary Remediation Goals (PRGs) except for Total PCBs (read below). However, it cannot be fully ascertained whether the COC or another contaminant caused the toxic effect represented by the LOEC. Because sediment samples comprise a complex mixture of multiple chemicals, a LOEC can be overly conservative for some COCs in a mixture. That is, a small concentration of a COC detected in a toxic sample for which other COCs are responsible can result in an inaccurately small LOEC concentration.

The MATC value calculated for Total PCBs in Table 2 (0.028 ug/kg) is significantly smaller

than PRGs established at other sites, such that its validity is questionable at such a low level. Therefore, in the case of Total PCBs, the MATC was not selected as the PRG. USEPA selected an average PCB concentration of 1 mg/kg as a sediment cleanup value to be used for risk management associated with B&M Pond and Unnamed Brook. This PRG is consistent with sediment cleanup values selected at other PCB sites in New England.

Figure A-1 presents COC concentrations at sediment locations in Unnamed Brook and B&M Pond. This figure shows those concentrations which are greater than MATCs or 1 mg/kg Total PCBs.

References

MacDonald, D.D., C.G. Ingersoll and T.A. Berger. 2000. *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems*. Arch. Environ. Contam. Toxicol. 39:20-31.

Metcalf & Eddy (M&E). 2006a. *Ecological Risk Assessment / Wetlands Remedial Investigation Addendum (ERA/WRIA)*, Iron Horse Park Superfund Site, Operable Unit 4, North Billerica, Massachusetts. September 2006.

TABLE 1
SELECTION OF SEDIMENT COC NO OBSERVED EFFECTS CONCENTRATIONS
IRON HORSE PARK SUPERFUND SITE - OU-4

COC	NOEC ⁽¹⁾	Reference Area	Study Area			
		Round Pond (SED-22)	Content Brook (SED-01)	B&M Pond (SED-05)	W. Middlesex Canal (SED-11)	Unnamed Brook (SED-18)
<u>PAHs (ug/kg)</u>						
Total PAH	1,932	923	1,932	129,975	613	12,097
<u>Pesticides/PCBs (ug/kg)</u>						
4,4'-DDD	14.5	14.5	2.69	92.5	3.1 R	18
Aroclor-1242	6.6 DL	6.6 DL	6.5 DL	65 DL	23	6.6 DL
Aroclor-1254	6.6 DL	6.6 DL	6.5 DL	2,695	6.6 DL	36
Aroclor-1260	13.7	13.7	12	1,940	6.6 DL	20
Total PCBs	14	14	12	4,635	23	56
<u>Metals (mg/kg)</u>						
Arsenic	360	3.1	360	75	2.9	61
Barium	370	27	370	325	28	110
Chromium	14	8.0	14	695	10	34
Copper	19	8.8	19	700	5.0	210
Lead	35	30	35	810	16	380
Manganese	1,600	250	1,600	605	220	490
Vanadium	19	13	19	44	7.5	28
Zinc	110	42	110	3,550	21	150

Source: Table 7-5 from Ecological Risk Assessment/Wetlands Remedial Investigation Addendum, Metcalf & Eddy, 2006

⁽¹⁾ NOEC set as the higher of the concentration observed at locations with no observed effects (SED-01 or SED-22)

COC - Contaminant of Concern

NOEC - No observed effects concentration

DL - Value represents the detection limit - compound was not detected

R - Value rejected - the value for SED-11 is the estimated maximum concentration (see text)

100 - Bold/italic values are at or below NOEC

Shading - sites with no observed sediment toxicity from which NOEC are selected

TABLE 2
SELECTION OF SEDIMENT COC LOWEST OBSERVED EFFECTS CONCENTRATIONS
AND MAXIMUM ACCEPTABLE TOXIC CONCENTRATIONS
IRON HORSE PARK SUPERFUND SITE - OU-4

COC	NOEC ⁽¹⁾	LOEC ⁽²⁾	B&M Pond (SED-05)	W. Middlesex Canal (SED-11)	Unnamed Brook (SED-18)	MATC ⁽³⁾
<u>PAHs (ug/kg)</u>						
Total PAH	1,932	12,097	129,975	613	12,097	4,834
<u>Pesticides/PCBs (ug/kg)</u>						
4,4'-DDD	14.5	18	92.5	3.1 R	18	16
Aroclor-1242	6.6 DL	23	65 DL	23	6.6 DL	12
Aroclor-1254	6.6 DL	36	2,695	6.6 DL	36	15
Aroclor-1260	13.7	20	1,940	6.6 DL	20	17
Total PCBs	14	56	4,635	23	56	28
<u>Metals (mg/kg)</u>						
Chromium	14	34	695	10	34	22
Copper	19	210	700	5.0	210	63
Lead	35	380	810	16	380	115
Vanadium	19	28	44	7.5	28	23
Zinc	110	150	3,550	21	150	128

⁽¹⁾ NOEC set as the higher of the concentrations observed at locations with no observed effects (SED-01 or SED-22), See Table 1

⁽²⁾ LOEC set as the lower of the concentrations observed at locations with observed toxicity (SED-05, SED-11, and SED-18) among the values that exceeded NOECs

⁽³⁾ MATC set as the geometric mean between the NOEC and LOEC values

COC - Contaminant of Concern; arsenic, barium, and manganese removed as COCs following comparison of sampling results to NOECs; see Table 1

NOEC - No observed effects concentration

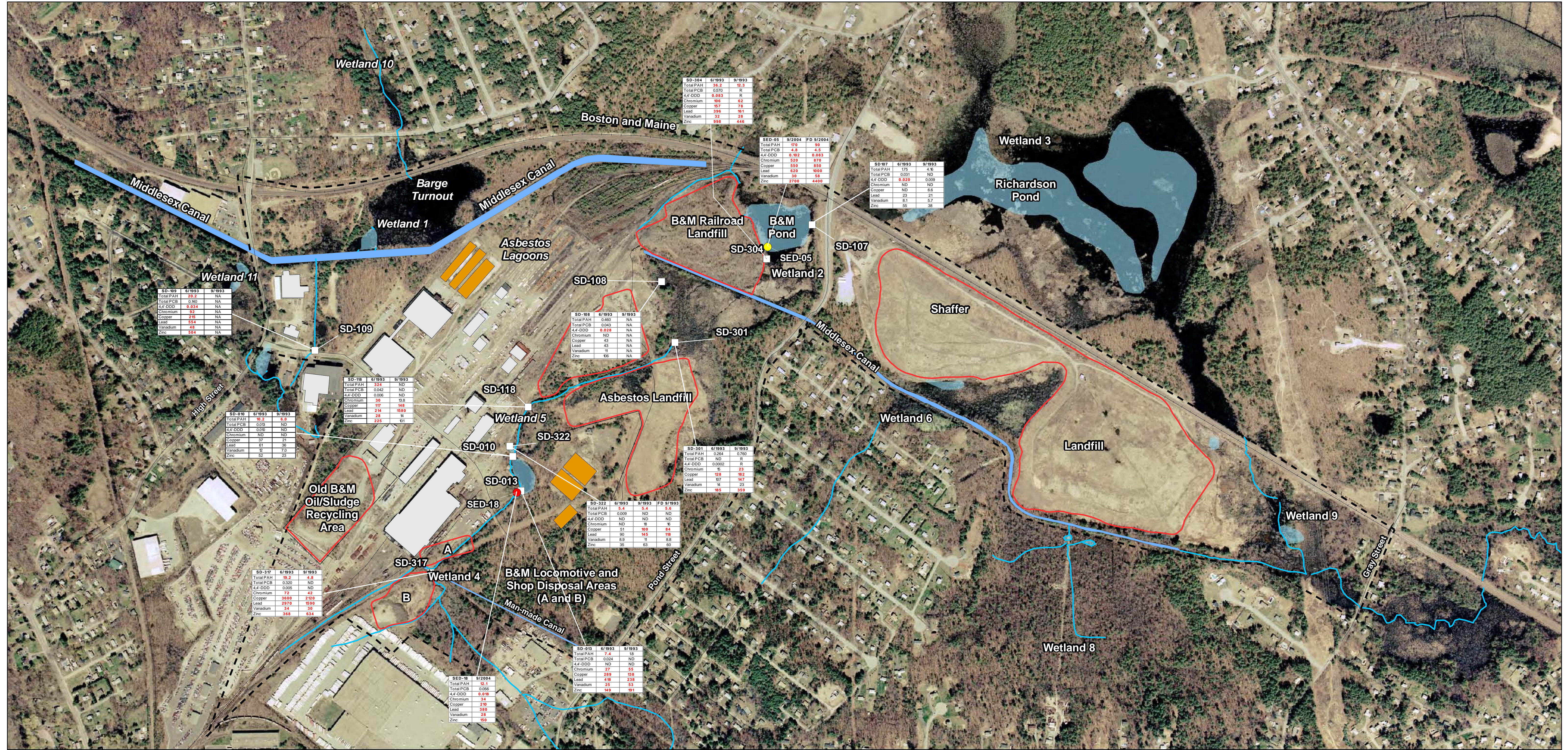
LOEC - Lowest observed effects concentration

MATC - Maximum Acceptable Toxic Concentration

DL - Value represents the detection limit - compound was not detected

R - Value rejected - the value for SED-11 is the estimated maximum concentration (see text)

100 - Bold/italic values are above MATC



G:\Project\H2\W\AST\ES\860032\IHP\Map\2010 FS Map\Figures\FigureA-1.mxd

Road

Railroad

Stream

Fence

Disposal Area boundary

Iron Horse Site Boundary

Surface Water

Lagoon

Building

Canal

1993 Sediment Sampling Location

2004 Sediment Sampling Location

Negligible Toxicity to Benthic Invertebrates as Indicated by Laboratory Toxicity Tests

Low Toxicity to Benthic Invertebrates as Indicated by Laboratory Toxicity Tests

Moderate Toxicity to Benthic Invertebrates as Indicated by Laboratory Toxicity Tests

N

W

E

S

0

200

400

800

1,200

1,600

Feet

*Red Concentration Values Indicate an Exceedance of the Preliminary Remediation Goal

COC - Contaminant of Concern

ND - Not Detected

NA - Not Analyzed

Concentrations are in mg/kg.

Locations for All Features Shown are Approximate. Extent of Wetland and Surface Waters are Limited to Areas Confirmed During Wetlands Reconnaissance on July 15, 1993 and November 8, 1994.

FIGURE A-1.

COC CONCENTRATIONS AT SEDIMENT SAMPLING LOCATIONS IN UNNAMED BROOK AND B&M POND

Iron Horse Park Superfund Site
North Billerica, MA

APPENDIX B

COST DEVELOPMENT

PLANNING COST ESTIMATE SUMMARY

Alternative: **GW-1: No Action**

Site: Iron Horse Park Superfund Site Location: North Billerica, Massachusetts Phase: FS Date: February 2010	Description: This alternative consists of no remedial action as a baseline comparison. Five year reviews would be performed under this alternative.
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PERIODIC COSTS

Description	QTY	UNIT	UNIT COST	TOTAL	NOTES
Five year review (through Year 30)	6	ea	\$10,000	\$60,000	30 years assumed; note that this is only for one area of concern at the site

\$60,000

TOTAL PERIODIC ANNUAL COST

\$2,000

PRESENT VALUE ANALYSIS

Cost Type	Total Cost Per Year	P/A Factor	Present Value	Notes
Capital Cost			\$0	
O&M Cost	\$0	12.4	\$0	
Periodic Cost	\$2,000	12.4	\$24,800	P/A factor from Lindeburg, 1982 for discount rate of 7% and a 30-year period of time

Total Present Value of Alternative

\$24,800

PLANNING COST ESTIMATE SUMMARY

Alternative: **GW-2: Limited Action**

Site: Iron Horse Park Superfund Site Location: North Billerica, Massachusetts Phase: FS Date: September 2010	Description: This alternative consists of groundwater monitoring (MNA parameters would be included.) Institutional controls would be implemented to restrict groundwater use.
---------------------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

CAPITAL COSTS

Description	QTY	UNIT	UNIT COST	TOTAL	NOTES
<u>Pre-Remedial Study</u>					
Monitoring Well Installation	15	ea	\$8,781	\$131,713	Estimated; <i>See Monitoring Well worksheet</i>
				\$131,713	
<u>Institutional Controls</u>					
Groundwater use restrictions	1	LS	\$9,000	\$9,000	Allowance for engineering, legal
				\$9,000	
SUBTOTAL				\$140,713	
Contingency:	20%			\$28,143	Bid (10%) + scope (10%)
SUBTOTAL [Remedy Implementation]				\$168,855	
Project Management	8.0%			\$13,508	
Remedial Design	15.0%			\$25,328	
Construction Management	10.0%			\$16,886	
				\$55,722	
TOTAL CAPITAL COST				\$224,577	

PLANNING COST ESTIMATE SUMMARY

Alternative: **GW-2: Limited Action**

O&M - ANNUAL

Description	QTY	UNIT	UNIT COST	TOTAL	NOTES
Site Monitoring					30 years assumed for costing purposes.
Groundwater sample collection/analysis	1.1	events	\$47,600	\$52,360	Assume 40 wells; VOCs, SVOCs, pesticides, metals, WQP, MNA; quarterly for first year; then annual
				\$52,360	
Contingency	30%			\$15,708	Allowance
SUBTOTAL				\$68,068	
Technical Support	15%			\$10,210	Estimated support for data evaluation
Project Management	5%			\$3,403	
TOTAL O&M ANNUAL COST				\$81,682	

PERIODIC COSTS

Description	QTY	UNIT	UNIT COST	TOTAL	NOTES
Five year review (through Year 30)	6	ea	\$10,000	\$60,000	30 years assumed for costing purposes. Note that this is only for one area of concern at the site
Monitoring Well Decommissioning	110	ea	\$397	\$43,700	Estimated; See MW Decommissioning worksheet
				\$103,700	
TOTAL PERIODIC ANNUAL COST				\$3,457	

PRESENT VALUE ANALYSIS

Cost Type	Total Cost Per Year	P/A Factor	Present Value	Notes
Capital Cost			\$224,577	
O&M Cost	\$81,682	12.4	\$1,012,852	P/A factor from Lindeburg, 1982 for discount rate of 7%
Periodic Cost	\$3,457	12.4	\$42,863	and a 30-year period of time
Total Present Value of Alternative			\$1,280,292	

PLANNING COST WORKSHEET

Alternative: GW-2: Limited Action
Worksheet Subject: Monitoring Wells

Site: Iron Horse Park Superfund Site	Prepared By: CC	Checked By: SC
Location: North Billerica, Massachusetts	Date: 2/11/10	Date: 2/12/10
Phase: FS		
Base Year: February 2010		

Work Statement:
 Installation of additional 5 overburden and 10 bedrock groundwater monitoring wells.

Description	QTY	UNIT	UNIT TOTAL	TOTAL
Overburden Wells				
HSA Drilling	1.67	DY	\$1,750	\$2,923
2" PVC, Schedule 40 well incl. sandpack & seal	50	LF	\$15	\$750
Lock and Cover	1	EA	\$150	\$150
Well Development: Pump & Surge	2	HR	\$300	\$600
Containerize and Stage 55 gallon drums	2	EA	\$100	\$200
Oversight	17	HR	\$110	\$1,870
SUBTOTAL (cost monitoring well)				\$6,493

Total Overburden Wells	5	EA	\$6,493	\$32,463
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Bedrock Wells				
Rotary Drilling - soil	50	LF	\$25	\$1,250
Rock Drilling	40	LF	\$75	\$3,000
2" PVC, Schedule 40 well incl. sandpack & seal	90	LF	\$15	\$1,350
2" Grout	0	LF	\$1.20	\$0
Lock and Cover	1	EA	\$150	\$150
Well Development: Pump & Surge	4	HR	\$300	\$1,200
Containerize and Stage 55 gallon drums	4	EA	\$100	\$400
Oversight	20	HR	\$110	\$2,200
SUBTOTAL (cost monitoring well)				\$9,550

Total Bedrock Wells	10	EA	\$9,550	\$95,500
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Drilling Mobilization	1	LS	\$2,000	\$2,000
Decon Pad	1	LS	\$750	\$750
Miscellaneous Costs	1	LS	\$1,000	\$1,000

TOTAL COST	\$131,713
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Cost per Well	\$8,781
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Source of Cost Data:
 Engineering estimate based on recent experience and subcontractor rates.

Cost Adjustment Factor:

FACTOR:		NOTES:
H&S Productivity (labor & equip)	<input type="text"/>	Level D
Escalation to Base Year	<input type="text"/>	
Area Cost Factor	<input type="text"/>	
Subcontractor Overhead & Prof.	<input type="text"/>	
Prime Contractor Overhead & Prof.	<input type="text"/>	

PLANNING COST WORKSHEET

Alternative: **GW-2: Limited Action**
Worksheet Subject: **Monitoring Well Decommissioning**

Site: Iron Horse Park Superfund Site
Location: North Billerica, Massachusetts
Phase: FS
Base Year: February 2010

Prepared By: CC
Date: 2/11/10

Checked By: SC
Date: 2/12/10

Work Statement:

Post-cleanup Well Abandonment/Decommissioning of groundwater monitoring wells. Estimate based on assumption of 110 wells at an average depth of 50 ft.

Description	QTY	UNIT	UNIT	
			TOTAL	TOTAL
Mob/Demob	1	LS	\$1,000	\$1,000
Equipment - truck, jackhammer	28	DY	\$200	\$5,600
Grout	500	CF	\$6	\$3,000
Grout placement	220	HR	\$150	\$33,000
Dispose mat'ls	110	EA	\$10	\$1,100

TOTAL COST \$43,700

As an estimate for decommissioning on a per-well basis, divide the total cost by the number of wells:

Cost per Well \$397

Source of Cost Data:

Engineering estimate based on recent experience.

Cost Adjustment Factor:

FACTOR:	
H&S Productivity (labor & equip)	<input type="text"/>
Escalation to Base Year	<input type="text"/>
Area Cost Factor	<input type="text"/>
Subcontractor Overhead & Prof.	<input type="text"/>
Prime Contractor Overhead & Prof.	<input type="text"/>

NOTES:
Level D

PLANNING COST WORKSHEET

Alternative: GW-2: Limited Action
Worksheet Subject: Sampling and Analysis Analysis

Site: Iron Horse Park Superfund Site **Prepared By:** CC **Checked By:** SC
Location: North Billerica, Massachusetts **Date:** 2/10/10 **Date:** 2/12/10
Phase: FS
Base Year: February 2010

Work Statement:
Costs for fixed laboratory analyses for groundwater are presented on this worksheet.

Fixed Laboratory Sample Analysis

	QTY	UNIT	LABOR	EQUIP	MTRL	UNIT TOTAL	TOTAL
VOC (aqueous)	1	EA	\$0.00	\$230.00	\$0.00	\$120.00	\$120.00
SVOCs/PAHs (aqueous)	1	EA	\$0.00	\$410.00	\$0.00	\$300.00	\$300.00
Pesticides (aqueous)	1	EA	\$0.00	\$410.00	\$0.00	\$100.00	\$100.00
Metals (aqueous)	1	EA	\$0.00	\$230.00	\$0.00	\$250.00	\$250.00
Monitored Natural Attenuation (aqueous)	1	EA	\$0.00	\$360.00	\$0.00	\$360.00	\$360.00
Water Quality Parameters (aqueous)	1	EA	\$0.00	\$125.00	\$0.00	\$200.00	\$200.00

SUBTOTAL (per aqueous sample) \$1,330.00

TOTAL SAMPLES (Groundwater) 20 \$1,330.00 \$26,600.00

Labor to Record and Collect Samples 100 HR \$110.00 \$0.00 \$0.00 \$110.00 \$11,000.00
Equipment Mobilization 1 LS \$0.00 \$10,000.00 \$0.00 \$10,000.00 \$10,000.00

TOTAL COST (Groundwater) **\$47,600**

Source of Cost Data:
Engineering estimate based on recent experience. Water quality parameters include alkalinity, chloride, nitrate, nitrite, ortho-phosphate, sulfate, and total organic carbon.

Cost Adjustment Factor:

FACTOR:	NOTES:
H&S Productivity (labor & equip)	<input style="width: 100px; height: 20px;" type="text"/>
Escalation to Base Year	<input style="width: 100px; height: 20px;" type="text"/>
Area Cost Factor	<input style="width: 100px; height: 20px;" type="text"/>
Subcontractor Overhead & Prof.	<input style="width: 100px; height: 20px;" type="text"/>
Prime Contractor Overhead & Prof.	<input style="width: 100px; height: 20px; text-align: center;" type="text" value="X"/>

PLANNING COST ESTIMATE SUMMARY

Alternative: SD-1: No Action

Site: Iron Horse Park Superfund Site	Description: This alternative consists of no remedial action as a baseline comparison.
Location: North Billerica, Massachusetts	Five year reviews would be performed under this alternative.
Phase: FS	
Date: February 2010	

PERIODIC COSTS

Description	QTY	UNIT	UNIT COST	TOTAL	NOTES
Five year review (through Year 30)	6	ea	\$10,000	\$60,000	30 years assumed; note that this is only for one area of concern at the site
				\$60,000	

TOTAL PERIODIC ANNUAL COST	\$2,000
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PRESENT VALUE ANALYSIS

Cost Type	Total Cost Per Year	P/A Factor	Present Value	Notes
Capital Cost			\$0	
O&M Cost	\$0	12.4	\$0	P/A factor from Lindeburg, 1982 for discount rate of 7%
Periodic Cost	\$2,000	12.4	\$24,800	and a 30-year period of time

Total Present Value of Alternative	\$24,800
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PLANNING COST ESTIMATE SUMMARY

Alternative: SD-4: Source Control - Excavation (B&M Pond) with Disposal

Site: Iron Horse Park Superfund Site	Description: This alternative consists of excavating and dewatering sediments
Location: North Billerica, Massachusetts	and disposing of them off-site. Areas outside of the excavation would be monitored.
Phase: FS	
Date: February 2010	

CAPITAL COSTS

Description	QTY	UNIT	UNIT COST	TOTAL	NOTES
<u>Site Preparation and Management</u>					
Equipment mobilization	1	LS	\$36,455	\$36,455	See General Conditions Worksheet
Planning and support	1	LS	\$22,780	\$22,780	See General Conditions Worksheet
Contractor field supervision	1	LS	\$54,000	\$54,000	See General Conditions Worksheet
Vegetation clearing	5	Acre	\$1,500	\$6,900	
Erosion control (silt fence/straw bales)	1,600	LF	\$7	\$11,200	
Silt curtain	1,400	LF	\$28	\$39,200	
Temporary Access	2,133	SY	\$16	\$34,133	Assumes 1,200 foot by 16 foot road
				<u>\$204,668</u>	
<u>Sediment Excavation and Restoration</u>					
Excavation and Transport to Staging Pad	7,407	CY	\$12	\$88,889	
Treatment of dewatering fluids	138,938	Gal	\$1	\$138,938	Assume on-site treatment system operation
					Add 10% drying reagent like lime or corn cob - assume 25%
Lime for Sediment Stabilization	833	Ton	\$100	\$83,333	will dewater by gravity and
Lime Blending	5,556	CY	\$6	\$33,333	75% require drying agent
Haz Sediment Transport and Off-site Disposal	3,056	Ton	\$160	\$488,889	Assumes 25% of material haz (includes 10% weight increase for lime)
Non Haz Sediment Transport and Off-site Disp	9,167	Ton	\$80	\$733,333	Assumes 75% of material non-haz (includes 10% weight increase for lime)
Sample Characterization	25	EA	\$815	\$20,375	
Wetlands Restoration	4.6	Acre	\$65,000	\$298,439	
				<u>\$1,885,529</u>	
SUBTOTAL				<u>\$2,090,198</u>	
Contingency:	30%			\$627,059	Scope (15%) + bid (15%)
SUBTOTAL [Remedy Implementation]				<u>\$2,717,257</u>	
Project Management	6.0%			\$163,035	
Remedial Design	12.0%			\$326,071	
Construction Management	8.0%			\$217,381	
				<u>\$706,487</u>	
TOTAL CAPITAL COST				\$3,423,744	

PLANNING COST ESTIMATE SUMMARY

Alternative: **SD-4: Source Control - Excavation (B&M Pond) with Disposal**

O&M - ANNUAL

Description	QTY	UNIT	UNIT COST	TOTAL	NOTES
Site Monitoring					
Sediment sample collection/analysis	2	events	\$19,750	\$39,500	Assume 10 samples, 2 events/year; PCBs, PAHs, metals, pesticides, and TOC; <i>See Sed Sampling Costs Worksheet</i>
				\$39,500	
Contingency	20%			\$7,900	Bid (10%) + scope (10%)
SUBTOTAL				\$47,400	
Technical Support	20%			\$9,480	Additional support needed for data evaluation/reporting
Project Management	5%			\$2,370	Minor support assumed
TOTAL O&M ANNUAL COST				\$59,250	

PERIODIC COSTS

Description	QTY	UNIT	UNIT COST	TOTAL	NOTES
Five year review (through Year 30)	4	ea	\$10,000	\$40,000	20 years assumed to be needed; note that this is only for one area of concern at the site
				\$40,000	
TOTAL PERIODIC ANNUAL COST				\$2,000	

PRESENT VALUE ANALYSIS

Cost Type	Total Cost Per Year	P/A Factor	Present Value	Notes
Capital Cost			\$3,423,744	
O&M Cost	\$59,250	10.59	\$627,458	P/A factor from Lindeburg, 1982 for discount rate of 7%
Periodic Cost	\$2,000	10.59	\$21,180	and a 20-year period of time
Total Present Value of Alternative			\$4,072,381	

PLANNING COST WORKSHEET

Alternative:
Worksheet Subject:

SD-4: Source Control - Excavation (B&M Pond) with Disposal
General Conditions (contractor plans, preparation, and supervision)

Site: Iron Horse Park Superfund Site
Location: North Billerica, Massachusetts
Phase: FS
Base Year: 2010

Prepared By: KMW
Date: 2/12/10

Checked By: NT
Date: 2/16/10

Work Statement:

The following sub-categories support contractor project planning, preparation, and supervision activities for sediment excavation with off-site disposal.

Planning and Support

	QTY	UNIT	LABOR	EQUIP	MTRL	UNIT TOTAL	TOTAL
Project estimating, scheduling and contracting	50	HR	\$125.00	\$0.00	\$1.00	\$126.00	\$6,300
HASP/Spill Prevention Plans	40	HR	\$85.00	\$0.00	\$1.00	\$86.00	\$3,440
Site management/Erosion control plans	40	HR	\$85.00	\$0.00	\$1.00	\$86.00	\$3,440
Permitting / meetings	100	HR	\$95.00	\$0.00	\$1.00	\$96.00	\$9,600
SUBTOTAL							\$22,780

Contractor Overhead & Profit

0.0% \$0

SUBTOTAL

\$22,780

Mobilization and Temporary Facilities

	QTY	UNIT	LABOR	EQUIP	MTRL	UNIT TOTAL	TOTAL
Equipment mobilization/demob	6	EA	\$400.00	\$1,000.00	\$0.00	\$1,400.00	\$8,400
Site vehicles (4)	2	MO	\$0.00	\$700.00	\$200.00	\$900.00	\$1,800
Air monitoring equipment	2	MO	\$0.00	\$4,000.00	\$0.00	\$4,000.00	\$8,000
Allowance for equipment/dewatering areas	1	LS	\$1,000.00	\$2,500.00	\$5,000.00	\$8,500.00	\$8,500
Water, storage, phones, portajohns, etc.	1	LS	\$0.00	\$5,000.00	\$0.00	\$5,000.00	\$5,000
SUBTOTAL							\$31,700

Contractor Overhead & Profit

15.0% \$4,755

SUBTOTAL

\$36,455

Supervision

	QTY	UNIT	LABOR	EQUIP	MTRL	UNIT TOTAL	TOTAL
Supervisor	40	DAY	\$675.00	\$0.00	\$0.00	\$675.00	\$27,000
H&S Officer / Air Monitoring	40	DAY	\$675.00	\$0.00	\$0.00	\$675.00	\$27,000
SUBTOTAL							\$54,000

Contractor Overhead & Profit

0.0% \$0

SUBTOTAL

\$54,000

Source of Cost Data:

Engineering estimate

Cost Adjustment Factor:

FACTOR:	NOTES:
H&S Productivity (labor & equip)	<input type="text"/>
Escalation to Base Year	<input type="text"/>
Area Cost Factor	<input type="text"/>
Subcontractor Overhead & Prof.	<input type="text"/>
Prime Contractor Overhead & Prof.	<input checked="" type="text"/>

PLANNING COST WORKSHEET

Alternative: SD-4: Source Control - Excavation (B&M Pond) with Disposal
Worksheet Subject: Sampling and Analysis

Site: Iron Horse Park Superfund Site Location: North Billerica, Massachusetts Phase: FS Base Year: 2010	Prepared By: KMW Date: 2/12/10	Checked By: NT Date: 2/16/10
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Work Statement:

Costs for fixed laboratory analyses for sediment are presented on this worksheet.

Fixed Laboratory Sample Analysis

	QTY	UNIT	LABOR	EQUIP	MTRL	UNIT TOTAL	TOTAL
VOC (wetland soil/sediment)	0	EA	\$0.00	\$160.00	\$0.00	\$160.00	\$0.00
SVOC (wetland soil/sediment)	0	EA	\$0.00	\$400.00	\$0.00	\$400.00	\$0.00
PAHs (wetland soil/sediment)	1	EA	\$0.00	\$150.00	\$0.00	\$150.00	\$150.00
PCB/Pest (wetland soil/sediment)	1	EA	\$0.00	\$250.00	\$0.00	\$250.00	\$250.00
TOC (wetland soil/sediment)	1	EA	\$0.00	\$50.00	\$0.00	\$50.00	\$50.00
Metals (wetland soil/sediment)	1	EA	\$0.00	\$365.00	\$0.00	\$365.00	\$365.00

SUBTOTAL (per wetland soil/sediment sample)		\$815.00
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TOTAL SAMPLES (Sediment)	10				\$815.00		\$8,150.00
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Labor to Record and Collect Samples	60	HR	\$110.00	\$0.00	\$0.00	\$110.00		\$6,600.00
Equipment Mobilization	1	LS	\$0.00	\$5,000.00	\$0.00	\$5,000.00		\$5,000.00

TOTAL COST (Sediment)	\$19,750
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Source of Cost Data:

Engineering estimate based on recent experience.

Cost Adjustment Factor:

FACTOR:	NOTES:
H&S Productivity (labor & equip)	<input type="text"/>
Escalation to Base Year	<input type="text"/>
Area Cost Factor	<input type="text"/>
Subcontractor Overhead & Prof.	<input type="text"/>
Prime Contractor Overhead & Prof.	<input checked="" type="text" value="X"/>

PLANNING COST ESTIMATE SUMMARY

Alternative: SD-6: Source Control - Excavation (B&M Pond and Unnamed Brook) with Disposal

Site: Iron Horse Park Superfund Site	Description: This alternative consists of excavating and dewatering sediments
Location: North Billerica, Massachusetts	and disposing of them off-site.
Phase: FS	
Date: September 2010	

CAPITAL COSTS

Description	QTY	UNIT	UNIT COST	TOTAL	NOTES
<u>Site Preparation and Management</u>					
Equipment mobilization	1	LS	\$66,470	\$66,470	See General Conditions Worksheet
Planning and support	1	LS	\$45,560	\$45,560	See General Conditions Worksheet
Contractor field supervision	1	LS	\$108,000	\$108,000	See General Conditions Worksheet
Vegetation clearing	6.6	Acre	\$1,500	\$9,833	
Erosion control (silt fence/straw bales)	15,000	LF	\$7	\$105,000	
Silt curtain	1,400	LF	\$28	\$39,200	
Temporary Access	14,400	SY	\$16	\$230,400	Assumes 8,100 foot (total) by 16 foot road
				\$604,463	
<u>Sediment Excavation and Restoration</u>					
Excavation and Transport to Staging Pad	10,576	CY	\$12	\$126,916	
Treatment of dewatering fluids	198,375	Gal	\$1	\$198,375	Assume on-site treatment system operation
					Add 10% drying reagent like lime or corn cob - assume 25%
Lime for Sediment Stabilization	1,190	Ton	\$100	\$118,983	will dewater by gravity and
Lime Blending	7,932	CY	\$6	\$47,593	75% require drying agent
Haz Sediment Transport and Off-site Disposal	4,363	Ton	\$160	\$698,036	Assumes 25% of material haz (includes 10% weight increase for lime)
Non Haz Sediment Transport and Off-site Disp	13,088	Ton	\$80	\$1,047,053	Assumes 75% of material non-haz (includes 10% weight increase for lime)
Sample Characterization	45	EA	\$815	\$36,675	
Wetlands Restoration	6.6	Acre	\$65,000	\$426,111	
				\$2,699,742	
SUBTOTAL				\$3,304,206	
Contingency:	30%			\$991,262	Scope (15%) + bid (15%)
SUBTOTAL [Remedy Implementation]				\$4,295,467	
Project Management	6.0%			\$257,728	
Remedial Design	12.0%			\$515,456	
Construction Management	8.0%			\$343,637	
				\$1,116,821	
TOTAL CAPITAL COST				\$5,412,289	

PRESENT VALUE ANALYSIS

Cost Type	Total Cost Per Year	P/A Factor	Present Value	Notes
Capital Cost			\$5,412,289	
O&M Cost			\$0	
Periodic Cost			\$0	

Total Present Value of Alternative **\$5,412,289**

PLANNING COST WORKSHEET

Alternative: SD-6: Source Control - Excavation (B&M Pond and Unnamed Brook) with Disposal
Worksheet Subject: General Conditions (contractor plans, preparation, and supervision)

Site: Iron Horse Park Superfund Site	Prepared/Revised By: KMW/SC	Checked By: NT
Location: North Billerica, Massachusetts	Date: 2/12/10	Date: 2/16/10
Phase: FS	9/15/10	9/15/10
Base Year: 2010		

Work Statement:

The following sub-categories support contractor project planning, preparation, and supervision activities for sediment excavation with off-site disposal.

Planning and Support

	QTY	UNIT	LABOR	EQUIP	MTRL	UNIT TOTAL	TOTAL
Project estimating, scheduling and contracting	100	HR	\$125.00	\$0.00	\$1.00	\$126.00	\$12,600
HASP/Spill Prevention Plans	80	HR	\$85.00	\$0.00	\$1.00	\$86.00	\$6,880
Site management/Erosion control plans	80	HR	\$85.00	\$0.00	\$1.00	\$86.00	\$6,880
Permitting / meetings	200	HR	\$95.00	\$0.00	\$1.00	\$96.00	\$19,200
SUBTOTAL							\$45,560

Contractor Overhead & Profit

0.0% \$0

SUBTOTAL \$45,560

Mobilization and Temporary Facilities

	QTY	UNIT	LABOR	EQUIP	MTRL	UNIT TOTAL	TOTAL
Equipment mobilization/demob	8	EA	\$400.00	\$1,000.00	\$0.00	\$1,400.00	\$11,200
Site vehicles (4)	4	MO	\$0.00	\$700.00	\$200.00	\$900.00	\$3,600
Air monitoring equipment	4	MO	\$0.00	\$4,000.00	\$0.00	\$4,000.00	\$16,000
Allowance for equipment/dewatering areas	1	LS	\$2,000.00	\$5,000.00	\$10,000.00	\$17,000.00	\$17,000
Water, storage, phones, portajohns, etc.	1	LS	\$0.00	\$10,000.00	\$0.00	\$10,000.00	\$10,000
SUBTOTAL							\$57,800

Contractor Overhead & Profit

15.0% \$8,670

SUBTOTAL \$66,470

Supervision

	QTY	UNIT	LABOR	EQUIP	MTRL	UNIT TOTAL	TOTAL
Supervisor	80	DAY	\$675.00	\$0.00	\$0.00	\$675.00	\$54,000
H&S Officer / Air Monitoring	80	DAY	\$675.00	\$0.00	\$0.00	\$675.00	\$54,000
SUBTOTAL							\$108,000

Contractor Overhead & Profit

0.0% \$0

SUBTOTAL \$108,000

Source of Cost Data:

Engineering estimate

Cost Adjustment Factor:

FACTOR:	NOTES:
H&S Productivity (labor & equip)	<input type="text"/>
Escalation to Base Year	<input type="text"/>
Area Cost Factor	<input type="text"/>
Subcontractor Overhead & Prof.	<input type="text"/>
Prime Contractor Overhead & Prof.	<input checked="" type="text" value="X"/>

PLANNING COST WORKSHEET

Alternative: SD-6: Source Control - Excavation (B&M Pond and Unnamed Brook) with Disposal
Worksheet Subject: Sampling and Analysis

Site: Iron Horse Park Superfund Site Prepared/Revised By: KMW/SC Checked By: NT
Location: North Billerica, Massachusetts Date: 2/12/10 Date: 2/16/10
Phase: FS 9/15/10 9/15/10
Base Year: 2010

Work Statement:

Costs for fixed laboratory analyses for sediment are presented on this worksheet.

Fixed Laboratory Sample Analysis

	QTY	UNIT	LABOR	EQUIP	MTRL	UNIT TOTAL	TOTAL
VOC (wetland soil/sediment)	0	EA	\$0.00	\$160.00	\$0.00	\$160.00	\$0.00
SVOC (wetland soil/sediment)	0	EA	\$0.00	\$400.00	\$0.00	\$400.00	\$0.00
PAHs (wetland soil/sediment)	1	EA	\$0.00	\$150.00	\$0.00	\$150.00	\$150.00
PCB/Pest (wetland soil/sediment)	1	EA	\$0.00	\$250.00	\$0.00	\$250.00	\$250.00
TOC (wetland soil/sediment)	1	EA	\$0.00	\$50.00	\$0.00	\$50.00	\$50.00
Metals (wetland soil/sediment)	1	EA	\$0.00	\$365.00	\$0.00	\$365.00	\$365.00

SUBTOTAL (per wetland soil/sediment sample) \$815.00

TOTAL SAMPLES (Sediment) 10 \$815.00 \$8,150.00

Labor to Record and Collect Samples	60	HR	\$110.00	\$0.00	\$0.00	\$110.00	\$6,600.00
Equipment Mobilization	1	LS	\$0.00	\$5,000.00	\$0.00	\$5,000.00	\$5,000.00

TOTAL COST (Sediment) **\$19,750**

Source of Cost Data:

Engineering estimate based on recent experience.

Cost Adjustment Factor:

FACTOR:	NOTES:
H&S Productivity (labor & equip)	<input type="text"/>
Escalation to Base Year	<input type="text"/>
Area Cost Factor	<input type="text"/>
Subcontractor Overhead & Prof.	<input type="text"/>
Prime Contractor Overhead & Prof.	<input checked="" type="text" value="X"/>

ESTIMATE OF TIMEFRAME FOR REDUCTION OF CONTAMINANT CONCENTRATIONS USING MNR

Using samples from same location 11 years apart, determine average amount of reduction per year for contaminants:

	SD-013 9/93	SED-18 9/04	11-Year % Reduction	Reduction/year
Cr	55	34	0.38	
V	53	28	0.47	
Zn	191	150	0.21	
		Avg:	0.36	0.032

Using most recent sediment sample from Unnamed Brook, determine average timeframe to achieve PRGs by applying rate of reduction per year:

PRELIMINARY REMEDIATION GOALS - SEDIMENT IRON HORSE PARK SUPERFUND SITE - OU-4

COC	NOEC ⁽¹⁾	LOEC ⁽²⁾	Selected PRG ⁽³⁾
<u>PAHs (ug/kg)</u>			
Total PAH	1,932	12,097	4,834
<u>Pesticides (ug/kg)</u>			
4,4'-DDD	14.5	18	16
<u>PCBs (mg/kg)</u>			
Total PCBs ⁽⁴⁾			1
<u>Metals (mg/kg)</u>			
Chromium	14	34	22
Copper	19	210	63
Lead	35	380	115
Vanadium	19	28	23
Zinc	110	150	128

Unnamed Brook	
SED-18 9/04	Using Reduc./yr Yrs to achieve PRG
12100	19
18	3
0.056	N/A
34	11
210	22
380	22
28	5
150	4
Avg:	12 yrs

Notes

⁽¹⁾ NOEC set as the higher of the concentrations observed at locations with no observed effects

⁽²⁾ LOEC set as the lower of the concentrations observed at locations with observed toxicity among the values that exceeded NOECs

⁽³⁾ The MATC (set as the geometric mean between the NOEC and LOEC values) has been selected as the PRG for each COC except Total PCBs.

⁽⁴⁾ See Appendix A for discussion of Total PCBs PRG development.

COC - Contaminant of Concern

NOEC - No observed effects concentration

LOEC - Lowest observed effects concentration

MATC - Maximum Acceptable Toxic Concentration

TABLE B-1. COST SENSITIVITY ANALYSIS SUMMARY

VARIABLE ALT #		TOTAL ALTERNATIVE COSTS				
		GW-1	GW-2	SD-1	SD-4	SD-6
Total	-30%	\$0	\$157,204	\$0	\$2,396,621	\$3,788,602
Capital Cost ¹	0%	\$0	\$224,577	\$0	\$3,423,744	\$5,412,289
	+50%	\$0	\$336,866	\$0	\$5,135,615	\$8,118,433
Total	-30%	\$1,400	\$59,597	\$1,400	\$41,475	\$0
Annual Cost ¹	0%	\$2,000	\$85,138	\$2,000	\$59,250	\$0
	+50%	\$3,000	\$127,707	\$3,000	\$88,875	\$0
Total Net	-30%	\$17,360	\$896,204	\$17,360	\$2,850,667	\$3,788,602
Present Value	0%	\$24,800	\$1,280,292	\$24,800	\$4,072,381	\$5,412,289
	+50%	\$37,200	\$1,920,437	\$37,200	\$6,108,572	\$8,118,433
P/A Factor	10 / 8 ⁽²⁾	\$20,000	\$1,075,960	\$20,000	\$3,913,744	N/A
Total Net	12.4 / 10.6 ⁽²⁾	\$24,800	\$1,280,292	\$24,800	\$4,072,381	\$5,412,289
Present Value	15 / 14 ⁽²⁾	\$30,000	\$1,501,651	\$30,000	\$4,281,244	N/A

Notes:

Boldface indicates base case conditions for the alternative.

1. Contingencies included prior to sensitivity analysis changes.
2. Second value shown applies to Alternative SD-4 due to an assumed 20-year time frame

APPENDIX C

ARARS

**TABLE C-1a. CHEMICAL-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE FOR
ALTERNATIVE GW-1: NO ACTION**

Authority	Requirement	Status	Requirement Synopsis	Consideration in the RI/FS
Groundwater				
Federal Regulatory Requirements	Safe Drinking Water Act (42 U.S.C. §300f <i>et seq.</i>); National primary drinking water regulations (40 CFR 141)	Relevant and Appropriate	Establishes MCLs for common organic and inorganic contaminants applicable to public drinking water supplies. Used as relevant and appropriate cleanup standards for aquifers and surface water bodies that are potential drinking water sources.	Property within the site boundary is classified by the State as “Non-potential Drinking Water Source Area.” Areas adjacent to and downgradient of the site, however, are classified as Potentially Productive Aquifers and are potential drinking water source areas. Analytes detected at the site at levels above MCLs are presented (along with the MCLs) in Table 8 of Appendix A. By not taking any action, it will not be possible to determine if the No Action alternative achieves MCLs, Non-zero MCLGs when there is no MCL or State drinking water standards, whichever is more stringent.
	Safe Drinking Water Act (42 U.S.C. §300f <i>et seq.</i>); National primary drinking water regulations (40 CFR 141)	Relevant and Appropriate for non-zero MCLGs only; MCLGs set as zero are To Be Considered.	Establishes maximum contaminant level goals (MCLGs) for public water supplies. MCLGs are health goals for drinking water sources. These unenforceable health goals are available for a number of organic and inorganic compounds.	Groundwater adjacent to and downgradient from the site boundary is considered a potential drinking water source. Non-zero MCLGs are relevant and appropriate. MCLGs set at zero are to be considered. By not taking any action, it will not be possible to determine if the No Action alternative achieves MCLs, Non-zero MCLGs when there is no MCL or State drinking water standards, whichever is more stringent.
Federal Criteria, Advisories, and Guidance	EPA Risk Reference Dose (RfDs)	To Be Considered	RfDs are considered to be the levels unlikely to cause significant adverse health effects associated with a threshold mechanism of action in human exposure for a lifetime.	Hazards due to noncarcinogens with EPA RfDs were used to develop target cleanup levels.
	EPA Carcinogenicity Slope Factor	To Be Considered	Slope factors are developed by EPA from health effects assessments. Carcinogenic effects present the most up-to-date information on cancer risk potency. Potency factors are developed by EPA from Health Effects Assessments of evaluation by the Carcinogenic Assessment Group.	Risks due to carcinogens as assessed with slope factors were used to develop target cleanup levels.
	Health Advisories (EPA Office of Drinking Water)	To Be Considered	Health Advisories are estimates of risk due to consumption of contaminated drinking water; they consider non-carcinogenic effects only. To be considered for contaminants in groundwater that may be used for drinking water	Health advisories will be used to evaluate the non-carcinogenic risk resulting from exposure to certain compounds (e.g., manganese).
State Regulatory Requirements	Massachusetts Drinking Water Regulations (310 CMR §22.00)	Relevant and Appropriate	Establishes maximum contaminant levels that apply to public drinking water supplies. Massachusetts Maximum Contaminant Levels and Maximum Contaminant Level Goals are specified for numerous contaminants, including inorganic and organic chemicals. For the most part, the numerical criteria are identical to Federal SDWA MCLs and MCLGs, although there are several additional chemicals that have criteria.	Since site groundwater is not used as a public drinking water supply, the criteria are not applicable. Since the site is adjacent to and upgradient of groundwater which is a potential drinking water supply, the criteria are relevant and appropriate to off-site groundwater. Because site groundwater is classified as potable, the Massachusetts MCLs are relevant and appropriate for site groundwater. By not taking any action, it will not be possible to determine if the No Action alternative achieves MCLs, Non-zero MCLGs when there is no MCL or State drinking water standards, whichever is more stringent.

There are no Location- or Action-Specific ARARs for the No Action Alternative

**TABLE C-2a. CHEMICAL-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE FOR
ALTERNATIVE GW-2: LIMITED ACTION**

Authority	Requirement	Status	Requirement Synopsis	Consideration in the RI/FS
Groundwater				
Federal Regulatory Requirements	Safe Drinking Water Act (42 U.S.C. §300f <i>et seq.</i>); National primary drinking water regulations (40 CFR 141)	Relevant and Appropriate	Establishes MCLs for common organic and inorganic contaminants applicable to public drinking water supplies. Used as relevant and appropriate cleanup standards for aquifers and surface water bodies that are potential drinking water sources.	Property within the site boundary is classified by the State as “Non-potential Drinking Water Source Area.” Areas adjacent to and downgradient of the site, however, are classified as Potentially Productive Aquifers and are potential drinking water source areas. Analytes detected at the site at levels above MCLs are presented (along with the MCLs) in Table 8 of Appendix A. Under this alternative, monitoring will be performed until groundwater achieves these standards.
	Safe Drinking Water Act (42 U.S.C. §300f <i>et seq.</i>); National primary drinking water regulations (40 CFR 141)	Relevant and Appropriate for non-zero MCLGs only; MCLGs set as zero are To Be Considered.	Establishes maximum contaminant level goals (MCLGs) for public water supplies. MCLGs are health goals for drinking water sources. These unenforceable health goals are available for a number of organic and inorganic compounds.	Groundwater adjacent to and downgradient from the site boundary is considered a potential drinking water source. Non-zero MCLGs are relevant and appropriate. MCLGs set at zero are to be considered. Under this alternative, monitoring will be performed until groundwater achieves these standards.
Federal Criteria, Advisories, and Guidance	EPA Risk Reference Dose (RfDs)	To Be Considered	RfDs are considered to be the levels unlikely to cause significant adverse health effects associated with a threshold mechanism of action in human exposure for a lifetime.	Hazards due to noncarcinogens with EPA RfDs were used to develop target cleanup levels. Under this alternative, monitoring will be performed until groundwater achieves contaminant levels that no longer pose a risk under these standards.
	EPA Carcinogenicity Slope Factor	To Be Considered	Slope factors are developed by EPA from health effects assessments. Carcinogenic effects present the most up-to-date information on cancer risk potency. Potency factors are developed by EPA from Health Effects Assessments of evaluation by the Carcinogenic Assessment Group.	Risks due to carcinogens as assessed with slope factors were used to develop target cleanup levels. Under this alternative, monitoring will be performed until groundwater achieves contaminant levels that no longer pose a risk under these standards.
	Health Advisories (EPA Office of Drinking Water)	To Be Considered	Health Advisories are estimates of risk due to consumption of contaminated drinking water; they consider non-carcinogenic effects only. To be considered for contaminants in groundwater that may be used for drinking water	Health advisories will be used to evaluate the non-carcinogenic risk resulting from exposure to certain compounds (e.g., manganese). Under this alternative, monitoring will be performed until groundwater achieves contaminant levels that no longer pose a risk under these standards.
State Regulatory Requirements	Massachusetts Drinking Water Regulations (310 CMR §22.00)	Relevant and Appropriate	Establishes maximum contaminant levels that apply to public drinking water supplies. Massachusetts Maximum Contaminant Levels and Maximum Contaminant Level Goals are specified for numerous contaminants, including inorganic and organic chemicals. For the most part, the numerical criteria are identical to Federal SDWA MCLs and MCLGs, although there are several additional chemicals that have criteria.	Since site groundwater is not used as a public drinking water supply, the criteria are not applicable. Since the site is adjacent to and upgradient of groundwater which is a potential drinking water supply, the criteria are relevant and appropriate to off-site groundwater. Because site groundwater is classified as potable, the Massachusetts MCLs are relevant and appropriate for site groundwater. Under this alternative, monitoring will be performed until groundwater achieves these standards.

**TABLE C-2b. LOCATION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE FOR
ALTERNATIVE GW-2: LIMITED ACTION**

Authority	Requirements	Status	Requirement Synopsis	Applicability To Site Conditions
<u>Wetlands, Floodplains, Streams, or Water Body</u>				
Federal Requirements	Fish and Wildlife Coordination Act (16 U.S.C.. §661 <i>et seq.</i>); Fish and wildlife protection (40 C.F.R. §6.302(g))	Applicable	Any modification of a body of water requires consultation with the U.S. Fish and Wildlife Services and the appropriate state wildlife agency to develop measures to prevent, mitigate, or compensate for losses of fish and wildlife.	The site includes streams, wetlands, and downstream waterbodies. Planning and decision-making with regard to monitoring well installation in wetlands will incorporate fish and wildlife protection considerations in consultation with the resource agencies.
	Executive Order 11990; "Protection of Wetlands" (40 C.F.R. Part 6, Appendix A)	Applicable	Under this requirement, no activity that adversely affects a wetland shall be permitted if a practicable alternative with lesser effects is available. Action to avoid, whenever possible, the long- and short-term impacts on wetlands and to preserve and enhance wetlands.	During identification, screening, and evaluation of alternatives, the effects on wetlands are evaluated. All practicable means will be used to minimize harm to the wetlands. Wetlands disturbed by well installation, maintenance, monitoring, or other remedial activities will be mitigated in accordance with requirements. The public will be kept informed of activities involving wetlands, as required.
	Clean Water Act, Section 404 (33 U.S.C.. § 1344); (40 C.F.R. Part 230 and 33 C.F.R. Parts 320-323)	Applicable	Under this requirement, no activity that adversely affects a wetland shall be permitted if a practicable alternative with lesser effects is available. Controls discharges of dredged or fill material to protect aquatic ecosystems.	Well installation, maintenance, and/or monitoring will be implemented to meet these requirements.
	Executive Order 11988; "Floodplain Management" (40 C.F.R. Part 6, Appendix A)	Applicable	Action to avoid, whenever possible, the long- and short-term impacts associated with the occupancy and modifications of floodplains development, wherever there is a practical alternative. Promotes the preservation and restoration of floodplains so that their natural and beneficial value can be realized.	The site includes areas defined to be within the 100-year floodplain. Well installation, maintenance, and/or monitoring will include all practicable means to minimize harm to and preserve beneficial values of floodplains. Floodplains disturbed by remedial actions will be restored to their original conditions and utility.

**TABLE C-2b. LOCATION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE FOR
ALTERNATIVE GW-2: LIMITED ACTION**

Authority	Requirements	Status	Requirement Synopsis	Applicability To Site Conditions
State Requirements	Wetlands Protection Act (Mass. Gen. Laws ch. 131, §40); Wetlands Protection Regulations (310 CMR §10.00)	Applicable	Sets performance standards for dredging, filling, altering of inland wetlands and within 100 feet of a wetland. The requirement also defines wetlands based on vegetation type and requires that effects on wetlands be mitigated. Resource areas at the site covered by the regulations include banks, bordering vegetated wetlands, land under bodies of water, land subject to flooding, riverfront, and estimated habitats of rare wildlife.	The site includes significant wetlands. Alternatives requiring that work be completed within 100 feet of a defined wetland, will comply with these regulations. Mitigation of impacts on wetlands due to well installation, maintenance, and/or monitoring will be addressed.
<u>Archaeological/Historic Sites</u>				
Federal Regulatory Requirements	National Historic Preservation Act of 1966 (16 U.S.C. §470 et seq.); Protection of Historic Properties (36 CFR part 800)	Applicable	Section 106 of the NHPA requires federal agencies to take into account the effects of their undertakings on historic properties and afford the Advisory Council on Historic Preservation a reasonable opportunity to comment.	Actions, such as well installation, maintenance, and/or monitoring, which may impact historical properties for which these requirements apply (such as the Middlesex Canal), must be coordinated with the Advisory Council on Historic Preservation.
	Historic Sites Act of 1935 (16 U.S.C. §469 et seq.); National historic landmarks (36 CFR Part 65)	Applicable	The purpose of the National Historic Landmarks program is to identify and designate National Historic Landmarks, and encourage the long range preservation of nationally significant properties that illustrate or commemorate the history and prehistory of the United States.	Actions, such as well installation, maintenance, and/or monitoring, which may impact historical properties for which these requirements apply (such as the Middlesex Canal), must be coordinated with the Department of the Interior.
State Regulatory Requirements	Antiquities Act and Regulations (Mass. Gen. Laws. ch. 9, §§26-27; Massachusetts Historical Commission (Mass. Regs. Code tit. 950, §70.00); Antiquities Act and Regulations (Mass.Gen.Laws. ch. 9, §§26-27; Protection of Properties Included in the State Register of Historic Places (950 CMR §71.00)	Relevant and Appropriate but Applicable where EPA Activity is on State Property	Projects which are state-funded or state-licensed or which are on state property must eliminate, minimize, or mitigate adverse effects to properties listed in the register of historic places. Establishes requirements for review of impacts for state-funded or state-licensed projects and projects on state-owned property. Establishes state register of historic places. Establishes coordination with the National Historic Preservation Act.	Actions, such as well installation, maintenance, and/or monitoring, which may impact the historical, architectural, archaeological, or cultural qualities of a property, whether listed or not, must be coordinated with the Massachusetts Historical Commission.

**TABLE C-2c. ACTION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE FOR
ALTERNATIVE GW-2: LIMITED ACTION**

Authority	Requirement	Status	Requirement Synopsis	Action to be taken to attain ARAR
Groundwater				
Federal Criteria, Advisories, and Guidance	EPA Groundwater Protection Strategy (August 1984; NCP Preamble, Vol 55, No. 46, March 8, 1990, 40 CFR Part 300, p. 8733); Guidelines for Ground-Water Classification (November 1986)	To Be Considered	The Groundwater Protection Strategy provides a common reference for preserving clean groundwater and protecting the public health against the effects of past contamination. Guidelines for consistency in groundwater protection programs focus on the highest beneficial use of a groundwater aquifer and define three classes of groundwater. These documents defined Class I, II and III groundwaters.	The role of CSGWPPs (Comprehensive State Ground Water Protection Programs) in EPA Remediation Programs (April 1997) defers groundwater use determination to the state for states that have a CSGWPP that is endorsed by EPA and has provisions for site-specific decisions. For states that do not have an EPA-endorsed CSGWPP, groundwater use determinations will follow the NCP preamble. MA has an EPA-endorsed CSGWPP at this time. A large portion of the site overlies a medium yield aquifer and design of a monitoring program will consider these guidelines.
	Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites. OSWER Directive 9200.4-17P, April 21, 1999	To Be Considered	This guidance sets criteria for evaluating monitored natural attenuation as a remedy at, among others, Superfund Sites.	MNA parameters are included in this remedy to allow for improved evaluation of potential contaminant reduction. Criteria noted in the guidance for assessing the natural attenuation will be utilized.

**TABLE C-3a. CHEMICAL-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE FOR
ALTERNATIVE SD-1: NO ACTION**

Authority	Requirement	Status	Requirement Synopsis	Consideration in the RI/FS
Sediment				
Federal Requirements	There are no set maximum allowable residual levels for chemicals in sediments under federal law.			
Federal Criteria, Advisories, and Guidance	NOAA Effects Range-Low (ERL) values for marine and estuarine sediments (Long et al., 1995; Long and Morgan, 1990)	To Be Considered	The ERL value is equivalent to the lower 10th percentile of the available toxicity data, which is estimated to be the approximate concentration at which adverse effects are likely to occur in sensitive life stages and/or species of sediment-dwelling organisms.	ERLs were used for selecting Chemicals of Potential Concern and for characterizing ecological effects. The No Action alternative fails to address risks identified under these standards.
	U.S. DOE, Office of Environmental Management, Secondary Chronic Values (SCVs) (Jones et al., 1997)	To Be Considered	The SCVs are toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota.	SCVs were used for selecting Chemicals of Potential Concern and for characterizing ecological effects. The No Action alternative fails to address risks identified under these standards.
	U.S. EPA Sediment Quality Criterion (SQC) and Sediment Quality Benchmarks (SQBs) (USEPA, 1996)	To Be Considered	SQCs and SQBs were established to provide screening toxicity thresholds.	SQCs and SQBs were used for selecting Chemicals of Potential Concern and for characterizing ecological effects. The No Action alternative fails to address risks identified under these standards.
	NOAA Screening Quick Reference Tables, Threshold Effects Level (TEL) (Buchman, 1999)	To Be Considered	TELs represent the concentration below which adverse effects are expected to occur only rarely.	TELs were used for selecting Chemicals of Potential Concern and for characterizing ecological effects. The No Action alternative fails to address risks identified under these standards.
Other guidance	Ontario Ministry of Environment and Energy (OMEE) Lowest Effect Levels (LELs) for Freshwater Sediments (Persaud et al., 1993)	To Be Considered	The LEL value is the concentration at which the majority of the sediment-dwelling organisms are not affected.	LELs were used for selecting Chemicals of Potential Concern and for characterizing ecological effects. The No Action alternative fails to address risks identified under these standards.
	Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. Probable Effects Concentrations (PECs) (MacDonald et al., 2000)	To Be Considered	The PEC value is the concentration above which the adverse effects on sediment-dwelling organisms are likely to occur.	PECs were used for characterizing ecological effects and for developing cleanup goals. The No Action alternative fails to address risks identified under these standards.

There are no Location- or Action-Specific ARARs for the No Action Alternative

**TABLE C-4a. CHEMICAL-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE FOR
ALTERNATIVE SD-4: SOURCE CONTROL - EXCAVATION (B&M POND) WITH DISPOSAL**

Authority	Requirement	Status	Requirement Synopsis	Consideration in the RI/FS
<u>Air</u>				
Federal Regulatory Requirements	Clean Air Act (42 U.S.C., §7401 <i>et seq.</i>); Standard for inactive waste disposal sites for asbestos mills and manufacturing and fabricating operations (40 CFR Part §61.151)	Applicable	NESHAPs establishes standards for inactive waste disposal sites for asbestos mills and manufacturing and fabricating operations, for active waste disposal sites, and disposal of asbestos-containing waste.	As asbestos is associated with the Iron Horse Park site, it is possible that the sediments in B&M Pond may contain asbestos. This alternative will be designed and implemented to comply with this standard.
Federal Criteria, Advisories, and Guidance	Threshold Limit Values (TLVs)	To Be Considered	These standards were issued as consensus standards for controlling air quality in work place environments.	TLVs will be used for assessing site inhalation risks for site remediation workers. This alternative will be designed and implemented to comply with this standard.
State Regulatory Requirements	Massachusetts Air Pollution Control Regulations (310 CMR 7.15)	Applicable	Provides standards for demolition and renovation of facilities or facility components that contain asbestos. Requires prevention of visible emissions of particulate matter when removing asbestos-containing materials.	The Iron Horse Park Site includes areas filled with asbestos-containing materials. These requirements are, therefore, applicable. This alternative will be designed and implemented to comply with this standard.
<u>Discharge to Publicly Owned Treatment Works</u>				
Federal Regulatory Requirements	RCRA-Pretreatment Standards (40 CFR 403)	Applicable	Discharges to a POTW must comply with the POTW's EPA-approved pretreatment requirements. POTWs in the area with approved pretreatment programs are being identified and the discharge must be treated to those levels required by the program.	If discharge to a POTW is utilized during dewatering, the remedy will be designed and implemented to meet these pretreatment standards.
<u>Sediment</u>				
Federal Requirements	There are no set maximum allowable residual levels for chemicals in sediments under federal law.			
Federal Criteria, Advisories, and Guidance	NOAA Effects Range-Low (ERL) values for marine and estuarine sediments (Long et al., 1995; Long and Morgan, 1990)	To Be Considered	The ERL value is equivalent to the lower 10th percentile of the available toxicity data, which is estimated to be the approximate concentration at which adverse effects are likely to occur in sensitive life stages and/or species of sediment-dwelling organisms.	ERLs were used for selecting Chemicals of Potential Concern and for characterizing ecological effects. Under this alternative, excavation will be performed to remove sediment in B&M Pond which poses a risk under these standards.
	U.S. DOE, Office of Environmental Management, Secondary Chronic Values (SCVs) (Jones et al., 1997)	To Be Considered	The SCVs are toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota.	SCVs were used for selecting Chemicals of Potential Concern and for characterizing ecological effects. Under this alternative, excavation will be performed to remove sediment in B&M Pond which poses a risk under these standards.
	U.S. EPA Sediment Quality Criterion (SQC) and Sediment Quality Benchmarks (SQBs) (USEPA, 1996)	To Be Considered	SQCs and SQBs were established to provide screening toxicity thresholds.	SQCs and SQBs were used for selecting Chemicals of Potential Concern and for characterizing ecological effects. Under this alternative, excavation will be performed to remove sediment in B&M Pond which poses a risk under these standards.
	NOAA Screening Quick Reference Tables, Threshold Effects Level (TEL) (Buchman, 1999)	To Be Considered	TELs represent the concentration below which adverse effects are expected to occur only rarely.	TELs were used for selecting Chemicals of Potential Concern and for characterizing ecological effects. Under this alternative, excavation will be performed to remove sediment in B&M Pond which poses a risk under these standards.

**TABLE C-4a. CHEMICAL-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE FOR
ALTERNATIVE SD-4: SOURCE CONTROL - EXCAVATION (B&M POND) WITH DISPOSAL**

Authority	Requirement	Status	Requirement Synopsis	Consideration in the RI/FS
Other guidance	Ontario Ministry of Environment and Energy (OMEE) Lowest Effect Levels (LELs) for Freshwater Sediments (Persaud et al., 1993)	To Be Considered	The LEL value is the concentration at which the majority of the sediment-dwelling organisms are not affected.	LELs were used for selecting Chemicals of Potential Concern and for characterizing ecological effects. Under this alternative, excavation will be performed to remove sediment in B&M Pond which poses a risk under these standards.
	Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. Probable Effects Concentrations (PECs) (MacDonald et al., 2000)	To Be Considered	The PEC value is the concentration above which the adverse effects on sediment-dwelling organisms are likely to occur.	PECs were used for characterizing ecological effects and for developing cleanup goals. Under this alternative, excavation will be performed to remove sediment in B&M Pond which poses a risk under these standards.

**TABLE C-4b. LOCATION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE FOR
ALTERNATIVE SD-4: SOURCE CONTROL - EXCAVATION (B&M POND) WITH DISPOSAL**

Authority	Requirements	Status	Requirement Synopsis	Applicability To Site Conditions
<u>Wetlands, Floodplains, Streams, or Water Body</u>				
Federal Requirements	Fish and Wildlife Coordination Act (16 U.S.C.. §661 <i>et seq.</i>); Fish and wildlife protection (40 C.F.R. §6.302(g))	Applicable	Any modification of a body of water requires consultation with the U.S. Fish and Wildlife Services and the appropriate state wildlife agency to develop measures to prevent, mitigate, or compensate for losses of fish and wildlife.	The site includes streams, wetlands, and downstream waterbodies. Planning and decision-making with respect to sediment excavation and monitoring will incorporate fish and wildlife protection considerations in consultation with the resource agencies.
	Executive Order 11990; "Protection of Wetlands" (40 C.F.R. Part 6, Appendix A)	Applicable	Under this requirement, no activity that adversely affects a wetland shall be permitted if a practicable alternative with lesser effects is available. Action to avoid, whenever possible, the long- and short-term impacts on wetlands and to preserve and enhance wetlands.	During identification, screening, and evaluation of alternatives, the effects on wetlands are evaluated. All practicable means will be used to minimize harm to the wetlands. Wetlands disturbed by sediment excavation and monitoring will be mitigated in accordance with requirements. The public will be kept informed of activities involving wetlands, as required.
	Clean Water Act, Section 404 (33 U.S.C.. § 1344); (40 C.F.R. Part 230 and 33 C.F.R. Parts 320-323)	Applicable	Under this requirement, no activity that adversely affects a wetland shall be permitted if a practicable alternative with lesser effects is available. Controls discharges of dredged or fill material to protect aquatic ecosystems.	Sediment excavation and monitoring will be designed and implemented to meet these requirements.
	Executive Order 11988; "Floodplain Management" (40 C.F.R. Part 6, Appendix A)	Applicable	Action to avoid, whenever possible, the long- and short-term impacts associated with the occupancy and modifications of floodplains development, wherever there is a practical alternative. Promotes the preservation and restoration of floodplains so that their natural and beneficial value can be realized.	The site includes areas defined to be within the 100-year floodplain. Remedial actions that involve construction in the floodplain areas will include all practicable means to minimize harm to and preserve beneficial values of floodplains. Floodplains disturbed by remedial actions will be restored to their original conditions and utility.
	Rivers and Harbors Act of 1899 (33 U.S.C. §401 <i>et seq.</i>); (33 CFR Part 320)	Relevant and Appropriate	Protects navigable rivers from unauthorized discharges or from unauthorized obstruction or alteration.	Remedial activities, such as excavation of sediments near Middlesex Canal, that cause alteration of navigable rivers will comply with this regulation.

**TABLE C-4b. LOCATION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE FOR
ALTERNATIVE SD-4: SOURCE CONTROL - EXCAVATION (B&M POND) WITH DISPOSAL**

Authority	Requirements	Status	Requirement Synopsis	Applicability To Site Conditions
State Requirements	Wetlands Protection Act (Mass. Gen. Laws ch. 131, §40); Wetlands Protection Regulations (310 CMR §10.00)	Applicable	Sets performance standards for dredging, filling, altering of inland wetlands and within 100 feet of a wetland. The requirement also defines wetlands based on vegetation type and requires that effects on wetlands be mitigated. Resource areas at the site covered by the regulations include banks, bordering vegetated wetlands, land under bodies of water, land subject to flooding, riverfront, and estimated habitats of rare wildlife.	Mitigation of impacts on wetlands due to excavation and monitoring will be addressed.
	Massachusetts Clean Waters Act (Mass. Gen. Laws ch. 21, §§26-53); Water Quality Certification for Discharge of Dredged or Fill Material, Dredging, and Dredged Materials in Waters of the United States within the Commonwealth (314 CMR §9.00)	Applicable	Establishes criteria and standards for dredging, handling and disposal of fill material and dredged material.	The excavation remedy will be designed and implemented to comply with requirements.
<u>Archaeological/Historic Sites</u>				
Federal Regulatory Requirements	National Historic Preservation Act of 1966 (16 U.S.C. §470 et seq.); Protection of Historic Properties (36 CFR part 800)	Applicable	Section 106 of the NHPA requires federal agencies to take into account the effects of their undertakings on historic properties and afford the Advisory Council on Historic Preservation a reasonable opportunity to comment.	Actions, such as nearby excavation and sediment monitoring, which may impact historical properties for which these requirements apply (such as the Middlesex Canal), must be coordinated with the Advisory Council on Historic Preservation.
	Historic Sites Act of 1935 (16 U.S.C. §469 et seq.); National historic landmarks (36 CFR Part 65)	Applicable	The purpose of the National Historic Landmarks program is to identify and designate National Historic Landmarks, and encourage the long range preservation of nationally significant properties that illustrate or commemorate the history and prehistory of the United States.	Actions, such as nearby excavation and sediment monitoring, which may impact historical properties for which these requirements apply (such as the Middlesex Canal), must be coordinated with the Department of the Interior.

**TABLE C-4b. LOCATION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE FOR
ALTERNATIVE SD-4: SOURCE CONTROL - EXCAVATION (B&M POND) WITH DISPOSAL**

Authority	Requirements	Status	Requirement Synopsis	Applicability To Site Conditions
State Regulatory Requirements	Antiquities Act and Regulations (Mass. Gen. Laws. ch. 9, §§26-27; Massachusetts Historical Commission (Mass. Regs. Code tit. 950, §70.00); Antiquities Act and Regulations (Mass.Gen.Laws. ch. 9, §§26-27; Protection of Properties Included in the State Register of Historic Places (950 CMR §71.00))	Relevant and Appropriate but Applicable where EPA Activity is on State Property	Projects which are state-funded or state-licensed or which are on state property must eliminate, minimize, or mitigate adverse effects to properties listed in the register of historic places. Establishes requirements for review of impacts for state-funded or state-licensed projects and projects on state-owned property. Establishes state register of historic places. Establishes coordination with the National Historic Preservation Act.	Actions, such as nearby excavation and sediment monitoring, which may impact the historical, architectural, archaeological, or cultural qualities of a property, whether listed or not, must be coordinated with the Massachusetts Historical Commission.

**TABLE C-4c. ACTION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE FOR
ALTERNATIVE SD-4: SOURCE CONTROL - EXCAVATION (B&M POND) WITH DISPOSAL**

Authority	Requirement	Status	Requirement Synopsis	Consideration in the RI/FS
Air				
Federal Requirements	Clean Air Act, NAAQS (40 CFR 50.6 - 50.7)	To Be Considered	This regulation specifies maximum primary and secondary 24-hour concentrations for particulate matter.	Standards for particulate matter will be met during excavation and handling of contaminated sediments. Activities during construction will include measures to suppress dust.
Massachusetts Requirements	Ambient Air Quality Standards (310 CMR 6.00)	Applicable	Sets primary and secondary ambient air quality standards for emissions of sulfur oxides, particulate matter, CO, ozone, nitrogen dioxide, and lead.	Dust standards will be complied with during any and all excavation of materials at the site.
	Massachusetts Air Pollution Control Regulations (310 CMR 7.09)	Relevant and Appropriate	Prohibits burning or emissions of dust which causes or contributes to a condition of air pollution. Standards for dust are contained in 310 CMR 7.09.	As remedial activities include excavation, these standards for particulate matter will be met.
	Air Pollution Control Regulations (310 CMR 7.00)	Applicable	Defines and regulates air pollution sources. Establishes emissions limitations for various processes and regions within the state. Sources require source approval and may require a study of health risks. All minor stationary sources are required to apply Best Available Control Technology (BACT) for each pollutant it would have the potential to emit. Major sources of volatile organic compounds (VOCs) are required to apply Lowest Achievable Emission Rate (LAER) and obtain offsets.	As excavation activities may generate dust, standards for dust will be complied with. No air sources will cause ambient air quality standards to be exceeded.
Federal Criteria, Advisories and Guidance	ACGIH (American Conference of Governmental Industrial Hygienists) Threshold Limiting Values (TLVs)	To Be Considered	TLVs are an estimate of the average safe airborne concentration of a substance in representative conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effect. These standards were issued as consensus standards for controlling air quality in work place environments.	TLVs could be used for assessing site inhalation risks for site remediation workers.
Massachusetts Criteria, Advisories, and Guidance	Massachusetts Threshold Effects Exposure Levels (TELs) and Allowable Ambient Limits (AALs) for Air (December 1995)	To Be Considered	These are guidelines used by Massachusetts DEP for air emission permit writing. Under the Clean Air Act Amendments, AALs may be utilized. TELs and AALs provide guidance when assessing significance of monitored and modeled residential contamination from air emissions. They also are used in evaluating worker safety.	AALs and TELs are to be considered when evaluating worker safety during site remediation, and for ambient air quality monitoring during any site remedy that involves disturbance of waste or contaminated materials.
Sediment				
Federal Requirements	RCRA - Standards Applicable to Generators of Hazardous Waste (40 CFR 262)	Applicable to any action that generates a hazardous waste	Generator requirements outline waste characterization, management of containers, packaging, labeling, and manifesting. Generator requirements apply to contaminated substances meeting the definition of RCRA-hazardous under 40 CFR 261. If contaminated substances at CERCLA sites are determined to be sufficiently similar to RCRA hazardous wastes, technical aspects of RCRA requirements are considered relevant and appropriate.	If removed from their location, hazardous substances must be handled, transported, and treated as RCRA hazardous waste. Waste characterization at the point of generation will be conducted to verify the applicability of these requirements.

**TABLE C-4c. ACTION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE FOR
ALTERNATIVE SD-4: SOURCE CONTROL - EXCAVATION (B&M POND) WITH DISPOSAL**

Authority	Requirement	Status	Requirement Synopsis	Consideration in the RI/FS
	Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material (40 CFR 230)	Applicable	Requirements for discharges of dredged or fill material are outlined. Under this requirement, no activity that impacts a wetland will be permitted if a practicable alternative that has less impact on the wetland is available. If there is no other practicable alternative, impacts must be mitigated.	Any unavoidable impacts to the wetlands will be mitigated, and a wetlands restoration plan will be developed and implemented. Monitoring of impacted wetlands will be conducted for three growing seasons following completion of the remedy.
	Executive Order 11990; "Protection of Wetlands" (40 CFR Part 6, Appendix A)	Applicable	Under this requirement, no activity that adversely affects a wetland shall be permitted if a practicable alternative with lesser effects is available. Adverse impacts range from construction or dredging of wetlands, to watershed damages, to leaving the wetlands degraded by contamination. Action to avoid, whenever possible, the long- and short-term impacts on wetlands and to preserve and enhance wetlands.	Any remedial actions will minimize and mitigate site damages to the wetlands. Wetlands and buffer zones disturbed by remedial activities will be mitigated in accordance with requirements. The public will be kept informed of activities involving wetlands, as required.
Other Guidance	Ontario Ministry of Environment and Energy (OMEE) Lowest and Severe Effect Levels (LELs and SELs) for Freshwater Sediments (Persaud et. al. 1993)	To Be Considered	Provides guidelines for 16 organochlorine insecticides, PCBs, PAHs, metals, and nutrients. The guidelines establish three levels of effect: (1) No Effect Level, the level at which the chemical in the sediment does not affect fish or sediment-dwelling organisms and does not transfer through the food chain; (2) Lowest Effect Level, a level of contamination that has no effect on the majority of sediment-dwelling organisms; and (3) Severe Effect Level, a level of contamination that is likely to affect the health of sediment-dwelling organisms and at which the sediment is considered heavily polluted.	The guidelines provide the basis for sediment-quality evaluations dealing with the problem of contaminated sediments. Exceedence of an LEL or SEL may require further action.
Massachusetts Requirements	Hazardous Waste Management - Requirements for Generators of Hazardous Waste (310 CMR 30.300)	Applicable to any action that generates a hazardous waste	Generator requirements outline waste characterization, management of containers, packaging, labeling, and manifesting. Generator requirements apply to contaminated substances meeting the definition of hazardous under 310 CMR 100.	If removed from their location, substances meeting the definition of Massachusetts hazardous wastes must be handled, transported, and treated according to these rules. Waste characterization at the point of generation will be conducted to verify the applicability of these hazardous waste generator requirements.
	Wetlands Protection Act (Mass. Gen. Laws ch. 131, §40); Wetlands Protection Regulations (310 CMR §10.00)	Applicable	Sets performance standards for dredging, filling, altering of inland wetlands and within 100 feet of a wetland. The requirement also defines wetlands based on vegetation type and requires that effects on wetlands be mitigated. Resource areas at the site covered by the regulations include banks, bordering vegetated wetlands, land under bodies of water, land subject to flooding, riverfront, and estimated habitats of rare wildlife.	Excavation and monitoring planning will address mitigation of impacts on that wetland.

**TABLE C-5a. CHEMICAL-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE FOR
ALTERNATIVE SD-6: SOURCE CONTROL - EXCAVATION (B&M POND AND UNNAMED BROOK) WITH DISPOSAL**

Authority	Requirement	Status	Requirement Synopsis	Consideration in the RI/FS
<u>Air</u>				
Federal Regulatory Requirements	Clean Air Act (42 U.S.C., §7401 <i>et seq.</i>); Standard for inactive waste disposal sites for asbestos mills and manufacturing and fabricating operations (40 CFR Part §61.151)	Applicable	NESHAPs establishes standards for inactive waste disposal sites for asbestos mills and manufacturing and fabricating operations, for active waste disposal sites, and disposal of asbestos-containing waste.	As asbestos is associated with the Iron Horse Park site, it is possible that the sediments in B&M Pond and Unnamed Brook may contain asbestos. This alternative will be designed and implemented to comply with this standard.
Federal Criteria, Advisories, and Guidance	Threshold Limit Values (TLVs)	To Be Considered	These standards were issued as consensus standards for controlling air quality in work place environments.	TLVs will be used for assessing site inhalation risks for site remediation workers. This alternative will be designed and implemented to comply with this standard.
State Regulatory Requirements	Massachusetts Air Pollution Control Regulations (310 CMR 7.15)	Applicable	Provides standards for demolition and renovation of facilities or facility components that contain asbestos. Requires prevention of visible emissions of particulate matter when removing asbestos-containing materials.	The Iron Horse Park Site includes areas filled with asbestos-containing materials. These requirements are, therefore, applicable. This alternative will be designed and implemented to comply with this standard.
<u>Discharge to Publicly Owned Treatment Works</u>				
Federal Regulatory Requirements	RCRA-Pretreatment Standards (40 CFR 403)	Applicable	Discharges to a POTW must comply with the POTW's EPA-approved pretreatment requirements. POTWs in the area with approved pretreatment programs are being identified and the discharge must be treated to those levels required by the program.	If discharge to a POTW is utilized during dewatering, the remedy will be designed and implemented to meet these pretreatment standards.
<u>Sediment</u>				
Federal Requirements	There are no set maximum allowable residual levels for chemicals in sediments under federal law.			
Federal Criteria, Advisories, and Guidance	NOAA Effects Range-Low (ERL) values for marine and estuarine sediments (Long et al., 1995; Long and Morgan, 1990)	To Be Considered	The ERL value is equivalent to the lower 10th percentile of the available toxicity data, which is estimated to be the approximate concentration at which adverse effects are likely to occur in sensitive life stages and/or species of sediment-dwelling organisms.	ERLs were used for selecting Chemicals of Potential Concern and for characterizing ecological effects. Under this alternative, excavation will be performed to remove sediment in B&M Pond and Unnamed Brook which poses a risk under these standards.
	U.S. DOE, Office of Environmental Management, Secondary Chronic Values (SCVs) (Jones et al., 1997)	To Be Considered	The SCVs are toxicological benchmarks for screening contaminants of potential concern for effects on sediment-associated biota.	SCVs were used for selecting Chemicals of Potential Concern and for characterizing ecological effects. Under this alternative, excavation will be performed to remove sediment in B&M Pond and Unnamed Brook which poses a risk under these standards.
	U.S. EPA Sediment Quality Criterion (SQC) and Sediment Quality Benchmarks (SQBs) (USEPA, 1996)	To Be Considered	SQCs and SQBs were established to provide screening toxicity thresholds.	SQCs and SQBs were used for selecting Chemicals of Potential Concern and for characterizing ecological effects. Under this alternative, excavation will be performed to remove sediment in B&M Pond and Unnamed Brook which poses a risk under these standards.
	NOAA Screening Quick Reference Tables, Threshold Effects Level (TEL) (Buchman, 1999)	To Be Considered	TELs represent the concentration below which adverse effects are expected to occur only rarely.	TELs were used for selecting Chemicals of Potential Concern and for characterizing ecological effects. Under this alternative, excavation will be performed to remove sediment in B&M Pond and Unnamed Brook which poses a risk under these standards.

**TABLE C-5a. CHEMICAL-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE FOR
ALTERNATIVE SD-6: SOURCE CONTROL - EXCAVATION (B&M POND AND UNNAMED BROOK) WITH DISPOSAL**

Authority	Requirement	Status	Requirement Synopsis	Consideration in the RI/FS
Other guidance	Ontario Ministry of Environment and Energy (OMEE) Lowest Effect Levels (LELs) for Freshwater Sediments (Persaud et al., 1993)	To Be Considered	The LEL value is the concentration at which the majority of the sediment-dwelling organisms are not affected.	LELs were used for selecting Chemicals of Potential Concern and for characterizing ecological effects. Under this alternative, excavation will be performed to remove sediment in B&M Pond and Unnamed Brook which poses a risk under these standards.
	Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. Probable Effects Concentrations (PECs) (MacDonald et al., 2000)	To Be Considered	The PEC value is the concentration above which the adverse effects on sediment-dwelling organisms are likely to occur.	PECs were used for characterizing ecological effects and for developing cleanup goals. Under this alternative, excavation will be performed to remove sediment in B&M Pond and Unnamed Brook which poses a risk under these standards.

**TABLE C-5b. LOCATION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE FOR
ALTERNATIVE SD-6: SOURCE CONTROL - EXCAVATION (B&M POND AND UNNAMED BROOK) WITH DISPOSAL**

Authority	Requirements	Status	Requirement Synopsis	Applicability To Site Conditions
<u>Wetlands, Floodplains, Streams, or Water Body</u>				
Federal Requirements	Fish and Wildlife Coordination Act (16 U.S.C.. §661 <i>et seq.</i>); Fish and wildlife protection (40 C.F.R. §6.302(g))	Applicable	Any modification of a body of water requires consultation with the U.S. Fish and Wildlife Services and the appropriate state wildlife agency to develop measures to prevent, mitigate, or compensate for losses of fish and wildlife.	The site includes streams, wetlands, and downstream waterbodies. Planning and decision-making with respect to sediment excavation and monitoring will incorporate fish and wildlife protection considerations in consultation with the resource agencies.
	Executive Order 11990; "Protection of Wetlands" (40 C.F.R. Part 6, Appendix A)	Applicable	Under this requirement, no activity that adversely affects a wetland shall be permitted if a practicable alternative with lesser effects is available. Action to avoid, whenever possible, the long- and short-term impacts on wetlands and to preserve and enhance wetlands.	During identification, screening, and evaluation of alternatives, the effects on wetlands are evaluated. All practicable means will be used to minimize harm to the wetlands. Wetlands disturbed by sediment excavation and monitoring will be mitigated in accordance with requirements. The public will be kept informed of activities involving wetlands, as required.
	Clean Water Act, Section 404 (33 U.S.C.. § 1344); (40 C.F.R. Part 230 and 33 C.F.R. Parts 320-323)	Applicable	Under this requirement, no activity that adversely affects a wetland shall be permitted if a practicable alternative with lesser effects is available. Controls discharges of dredged or fill material to protect aquatic ecosystems.	Sediment excavation and monitoring will be designed and implemented to meet these requirements.
	Executive Order 11988; "Floodplain Management" (40 C.F.R. Part 6, Appendix A)	Applicable	Action to avoid, whenever possible, the long- and short-term impacts associated with the occupancy and modifications of floodplains development, wherever there is a practical alternative. Promotes the preservation and restoration of floodplains so that their natural and beneficial value can be realized.	The site includes areas defined to be within the 100-year floodplain. Remedial actions that involve construction in the floodplain areas will include all practicable means to minimize harm to and preserve beneficial values of floodplains. Floodplains disturbed by remedial actions will be restored to their original conditions and utility.
	Rivers and Harbors Act of 1899 (33 U.S.C. §401 <i>et seq.</i>); (33 CFR Part 320)	Relevant and Appropriate	Protects navigable rivers from unauthorized discharges or from unauthorized obstruction or alteration.	Remedial activities, such as excavation of sediments near Middlesex Canal, that cause alteration of navigable rivers will comply with this regulation.

**TABLE C-5b. LOCATION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE FOR
ALTERNATIVE SD-6: SOURCE CONTROL - EXCAVATION (B&M POND AND UNNAMED BROOK) WITH DISPOSAL**

Authority	Requirements	Status	Requirement Synopsis	Applicability To Site Conditions
State Requirements	Wetlands Protection Act (Mass. Gen. Laws ch. 131, §40); Wetlands Protection Regulations (310 CMR §10.00)	Applicable	Sets performance standards for dredging, filling, altering of inland wetlands and within 100 feet of a wetland. The requirement also defines wetlands based on vegetation type and requires that effects on wetlands be mitigated. Resource areas at the site covered by the regulations include banks, bordering vegetated wetlands, land under bodies of water, land subject to flooding, riverfront, and estimated habitats of rare wildlife.	Mitigation of impacts on wetlands due to excavation and monitoring will be addressed.
	Massachusetts Clean Waters Act (Mass. Gen. Laws ch. 21, §§26-53); Water Quality Certification for Discharge of Dredged or Fill Material, Dredging, and Dredged Materials in Waters of the United States within the Commonwealth (314 CMR §9.00)	Applicable	Establishes criteria and standards for dredging, handling and disposal of fill material and dredged material.	The excavation remedy will be designed and implemented to comply with requirements.
<u>Archaeological/Historic Sites</u>				
Federal Regulatory Requirements	National Historic Preservation Act of 1966 (16 U.S.C. §470 et seq.); Protection of Historic Properties (36 CFR part 800)	Applicable	Section 106 of the NHPA requires federal agencies to take into account the effects of their undertakings on historic properties and afford the Advisory Council on Historic Preservation a reasonable opportunity to comment.	Actions, such as nearby excavation and sediment monitoring, which may impact historical properties for which these requirements apply (such as the Middlesex Canal), must be coordinated with the Advisory Council on Historic Preservation.
	Historic Sites Act of 1935 (16 U.S.C. §469 et seq.); National historic landmarks (36 CFR Part 65)	Applicable	The purpose of the National Historic Landmarks program is to identify and designate National Historic Landmarks, and encourage the long range preservation of nationally significant properties that illustrate or commemorate the history and prehistory of the United States.	Actions, such as nearby excavation and sediment monitoring, which may impact historical properties for which these requirements apply (such as the Middlesex Canal), must be coordinated with the Department of the Interior.

**TABLE C-5b. LOCATION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE FOR
ALTERNATIVE SD-6: SOURCE CONTROL - EXCAVATION (B&M POND AND UNNAMED BROOK) WITH DISPOSAL**

Authority	Requirements	Status	Requirement Synopsis	Applicability To Site Conditions
State Regulatory Requirements	Antiquities Act and Regulations (Mass. Gen. Laws. ch. 9, §§26-27; Massachusetts Historical Commission (Mass. Regs. Code tit. 950, §70.00); Antiquities Act and Regulations (Mass.Gen.Laws. ch. 9, §§26-27; Protection of Properties Included in the State Register of Historic Places (950 CMR §71.00))	Relevant and Appropriate but Applicable where EPA Activity is on State Property	Projects which are state-funded or state-licensed or which are on state property must eliminate, minimize, or mitigate adverse effects to properties listed in the register of historic places. Establishes requirements for review of impacts for state-funded or state-licensed projects and projects on state-owned property. Establishes state register of historic places. Establishes coordination with the National Historic Preservation Act.	Actions, such as nearby excavation and sediment monitoring, which may impact the historical, architectural, archaeological, or cultural qualities of a property, whether listed or not, must be coordinated with the Massachusetts Historical Commission.

**TABLE C-5c. ACTION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE FOR
ALTERNATIVE SD-6: SOURCE CONTROL - EXCAVATION (B&M POND AND UNNAMED BROOK) WITH DISPOSAL**

Authority	Requirement	Status	Requirement Synopsis	Consideration in the RI/FS
Air				
Federal Requirements	Clean Air Act, NAAQS (40 CFR 50.6 - 50.7)	To Be Considered	This regulation specifies maximum primary and secondary 24-hour concentrations for particulate matter.	Standards for particulate matter will be met during excavation and handling of contaminated sediments. Activities during construction will include measures to suppress dust.
Massachusetts Requirements	Ambient Air Quality Standards (310 CMR 6.00)	Applicable	Sets primary and secondary ambient air quality standards for emissions of sulfur oxides, particulate matter, CO, ozone, nitrogen dioxide, and lead.	Dust standards will be complied with during any and all excavation of materials at the site.
	Massachusetts Air Pollution Control Regulations (310 CMR 7.09)	Relevant and Appropriate	Prohibits burning or emissions of dust which causes or contributes to a condition of air pollution. Standards for dust are contained in 310 CMR 7.09.	As remedial activities include excavation, these standards for particulate matter will be met.
	Air Pollution Control Regulations (310 CMR 7.00)	Applicable	Defines and regulates air pollution sources. Establishes emissions limitations for various processes and regions within the state. Sources require source approval and may require a study of health risks. All minor stationary sources are required to apply Best Available Control Technology (BACT) for each pollutant it would have the potential to emit. Major sources of volatile organic compounds (VOCs) are required to apply Lowest Achievable Emission Rate (LAER) and obtain offsets.	As excavation activities may generate dust, standards for dust will be complied with. No air sources will cause ambient air quality standards to be exceeded.
Federal Criteria, Advisories and Guidance	ACGIH (American Conference of Governmental Industrial Hygienists) Threshold Limiting Values (TLVs)	To Be Considered	TLVs are an estimate of the average safe airborne concentration of a substance in representative conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effect. These standards were issued as consensus standards for controlling air quality in work place environments.	TLVs could be used for assessing site inhalation risks for site remediation workers.
Massachusetts Criteria, Advisories, and Guidance	Massachusetts Threshold Effects Exposure Levels (TELs) and Allowable Ambient Limits (AALs) for Air (December 1995)	To Be Considered	These are guidelines used by Massachusetts DEP for air emission permit writing. Under the Clean Air Act Amendments, AALs may be utilized. TELs and AALs provide guidance when assessing significance of monitored and modeled residential contamination from air emissions. They also are used in evaluating worker safety.	AALs and TELs are to be considered when evaluating worker safety during site remediation, and for ambient air quality monitoring during any site remedy that involves disturbance of waste or contaminated materials.
Sediment				
Federal Requirements	RCRA - Standards Applicable to Generators of Hazardous Waste (40 CFR 262)	Applicable to any action that generates a hazardous waste	Generator requirements outline waste characterization, management of containers, packaging, labeling, and manifesting. Generator requirements apply to contaminated substances meeting the definition of RCRA-hazardous under 40 CFR 261. If contaminated substances at CERCLA sites are determined to be sufficiently similar to RCRA hazardous wastes, technical aspects of RCRA requirements are considered relevant and appropriate.	If removed from their location, hazardous substances must be handled, transported, and treated as RCRA hazardous waste. Waste characterization at the point of generation will be conducted to verify the applicability of these requirements.

**TABLE C-5c. ACTION-SPECIFIC ARARS, CRITERIA, ADVISORIES, AND GUIDANCE FOR
ALTERNATIVE SD-6: SOURCE CONTROL - EXCAVATION (B&M POND AND UNNAMED BROOK) WITH DISPOSAL**

Authority	Requirement	Status	Requirement Synopsis	Consideration in the RI/FS
	Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material (40 CFR 230)	Applicable	Requirements for discharges of dredged or fill material are outlined. Under this requirement, no activity that impacts a wetland will be permitted if a practicable alternative that has less impact on the wetland is available. If there is no other practicable alternative, impacts must be mitigated.	Any unavoidable impacts to the wetlands will be mitigated, and a wetlands restoration plan will be developed and implemented. Monitoring of impacted wetlands will be conducted for three growing seasons following completion of the remedy.
	Executive Order 11990; "Protection of Wetlands" (40 CFR Part 6, Appendix A)	Applicable	Under this requirement, no activity that adversely affects a wetland shall be permitted if a practicable alternative with lesser effects is available. Adverse impacts range from construction or dredging of wetlands, to watershed damages, to leaving the wetlands degraded by contamination. Action to avoid, whenever possible, the long- and short-term impacts on wetlands and to preserve and enhance wetlands.	Any remedial actions will minimize and mitigate site damages to the wetlands. Wetlands and buffer zones disturbed by remedial activities will be mitigated in accordance with requirements. The public will be kept informed of activities involving wetlands, as required.
Other Guidance	Ontario Ministry of Environment and Energy (OMEE) Lowest and Severe Effect Levels (LELs and SELs) for Freshwater Sediments (Persaud et. al. 1993)	To Be Considered	Provides guidelines for 16 organochlorine insecticides, PCBs, PAHs, metals, and nutrients. The guidelines establish three levels of effect: (1) No Effect Level, the level at which the chemical in the sediment does not affect fish or sediment-dwelling organisms and does not transfer through the food chain; (2) Lowest Effect Level, a level of contamination that has no effect on the majority of sediment-dwelling organisms; and (3) Severe Effect Level, a level of contamination that is likely to affect the health of sediment-dwelling organisms and at which the sediment is considered heavily polluted.	The guidelines provide the basis for sediment-quality evaluations dealing with the problem of contaminated sediments. Exceedence of an LEL or SEL may require further action.
Massachusetts Requirements	Hazardous Waste Management - Requirements for Generators of Hazardous Waste (310 CMR 30.300)	Applicable to any action that generates a hazardous waste	Generator requirements outline waste characterization, management of containers, packaging, labeling, and manifesting. Generator requirements apply to contaminated substances meeting the definition of hazardous under 310 CMR 100.	If removed from their location, substances meeting the definition of Massachusetts hazardous wastes must be handled, transported, and treated according to these rules. Waste characterization at the point of generation will be conducted to verify the applicability of these hazardous waste generator requirements.
	Wetlands Protection Act (Mass. Gen. Laws ch. 131, §40); Wetlands Protection Regulations (310 CMR §10.00)	Applicable	Sets performance standards for dredging, filling, altering of inland wetlands and within 100 feet of a wetland. The requirement also defines wetlands based on vegetation type and requires that effects on wetlands be mitigated. Resource areas at the site covered by the regulations include banks, bordering vegetated wetlands, land under bodies of water, land subject to flooding, riverfront, and estimated habitats of rare wildlife.	Excavation and monitoring planning will address mitigation of impacts on that wetland.